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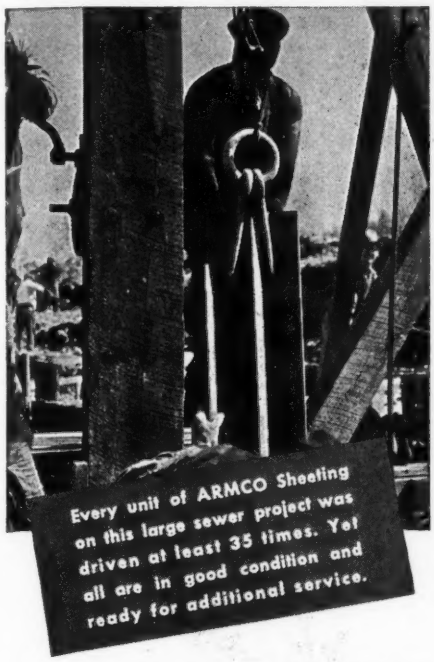
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VOL. 72. NO. 11

A. PRESCOTT FOLWELL, Editor

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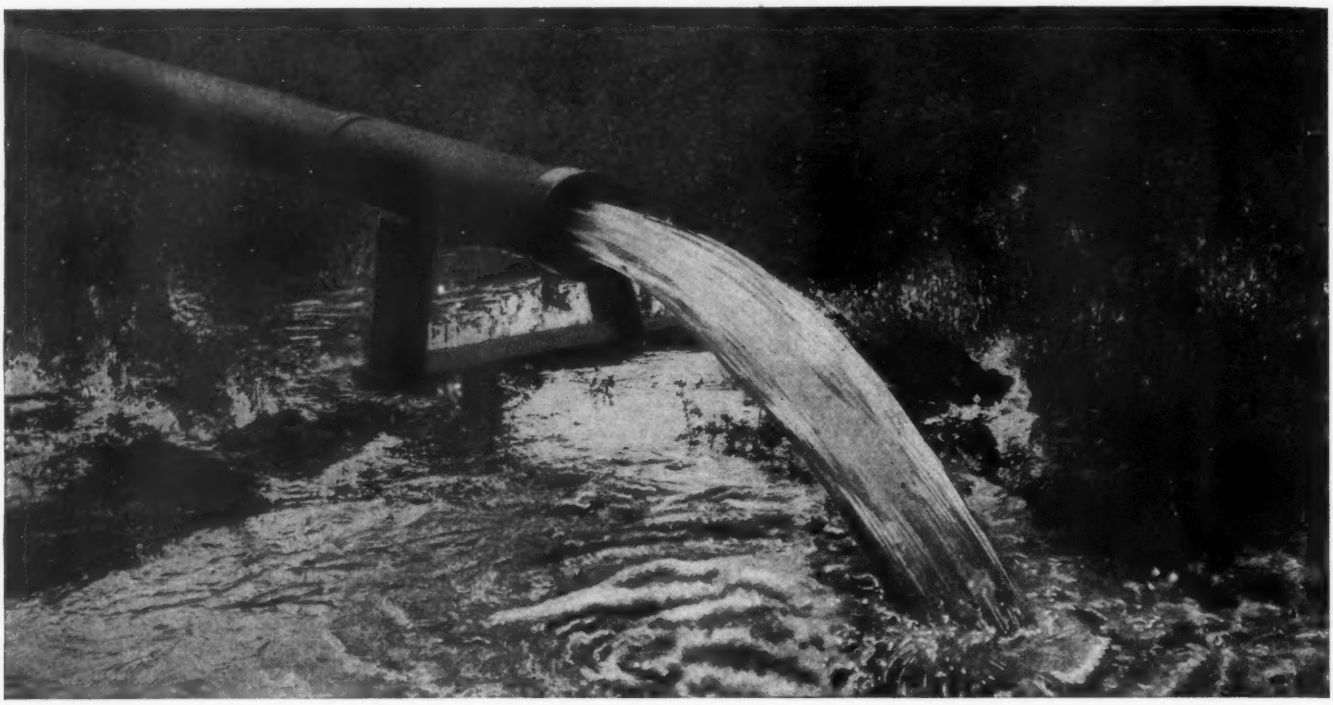
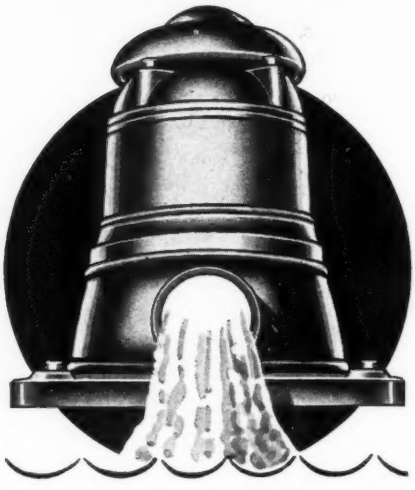


A COOL MILLION
and A Half Gallons Per Day



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The Editor's Page

Priorities for Highway Maintenance

Owing to the greater numbers of heavier loads imposed on roads near defense work plants, such roads will require more materials and equipment for repairs and maintenance than in the past. OPM Preference Rating Order P-22, issued to meet this demand, was inadeuate, in the opinion of the American Road Builders Association, and it has for several months been urging the issuance of an order directed specifically to highway maintenance. On Oct. 28 the OPM informed the A.R.B.A. that "a broad solution of the equipment problem, covering the entire field of earth excavating and moving machinery" is being prepared and "immediate steps are being taken to assist manufacturers of snow plows in securing the material needed for plows destined for states, counties, municipalities and other governmental agencies."

Testing Water for Pathogenic Bacteria

"Water works operators, particularly those handling marginal water supplies (treated sewage-polluted water), should exercise extreme care in making bacteriological tests for coliform organisms and should attempt to make their treatment processes so effective that no coliform organisms are ever found in the finished water." So spoke a bacteriologist in a paper before the New England Water Works Association. (See this month's Waterworks Digest.)

A few weeks previous, before the same association, a biologist-engineer had said: "Waterworks engineers . . . must at times feel that the water bacteriologist is too coliform conscious, since he is frequently stampeded into making dire predictions from a bubble of gas in a tube of lactose broth." He said that there are other gas-producing organisms which can not be distinguished from *Aerobacter* by any known method. "It is evident, then, that the appearance of gas in a lactose broth tube in 48 hours is not an absolute criterion of the presence of a member of the coliform group and even less a criterion of fecal pollution."

A hasty reading of the above might lead one to think that the two ideas quoted are somewhat contradictory. But it should be noted that the first refers to treating sewage-polluted water, the second to the selection of a source of supply. As to the latter, most engineers consider laboratory determination of the probable presence of coliform bacteria less important than the data collected by a sanitary survey of the watershed. Moreover, they consider that any surface supply is subject to occasional fecal pollution, and therefore sterilize all such supplies with chlorine. They even will adopt water known to be highly polluted, confident that they can make it safe. That consumers are equally confident in their ability to do so is indicated by the recent vote by Philadelphians to continue use of the purified waters of highly polluted rivers rather than spend $100 per capita to obtain much less polluted supplies from a more distant source.

As to supplies obtained by treating water known to be sewage-polluted, conditions are entirely different. Here laboratory analyses are the only way of determining the safety of the purified water. The question is, how reliable are such analyses? One of the authors quoted above thinks that the indications of coliform bacteria obtained by the standard analytical methods are by no means positive proof of the presence of pathogenic bacteria. The other advanced the idea that there are some pathogenic bacteria that escape detection by standard methods of analysis; and that therefore more effective analytical methods are needed.

Probably both are right. They agree in believing that present methods of determining the presence or absence of pathogenic organisms in treatment plant effluents are unsatisfactory, not reliably determining either. In view of the millions of lives and dollars affected by such determination, it is to be hoped that bacteriologists will continue their efforts to develop laboratory methods that all will accept as reliably definite proof of the absence of pathogenic bacteria in water.

The Liberty Biofilter's Second Season

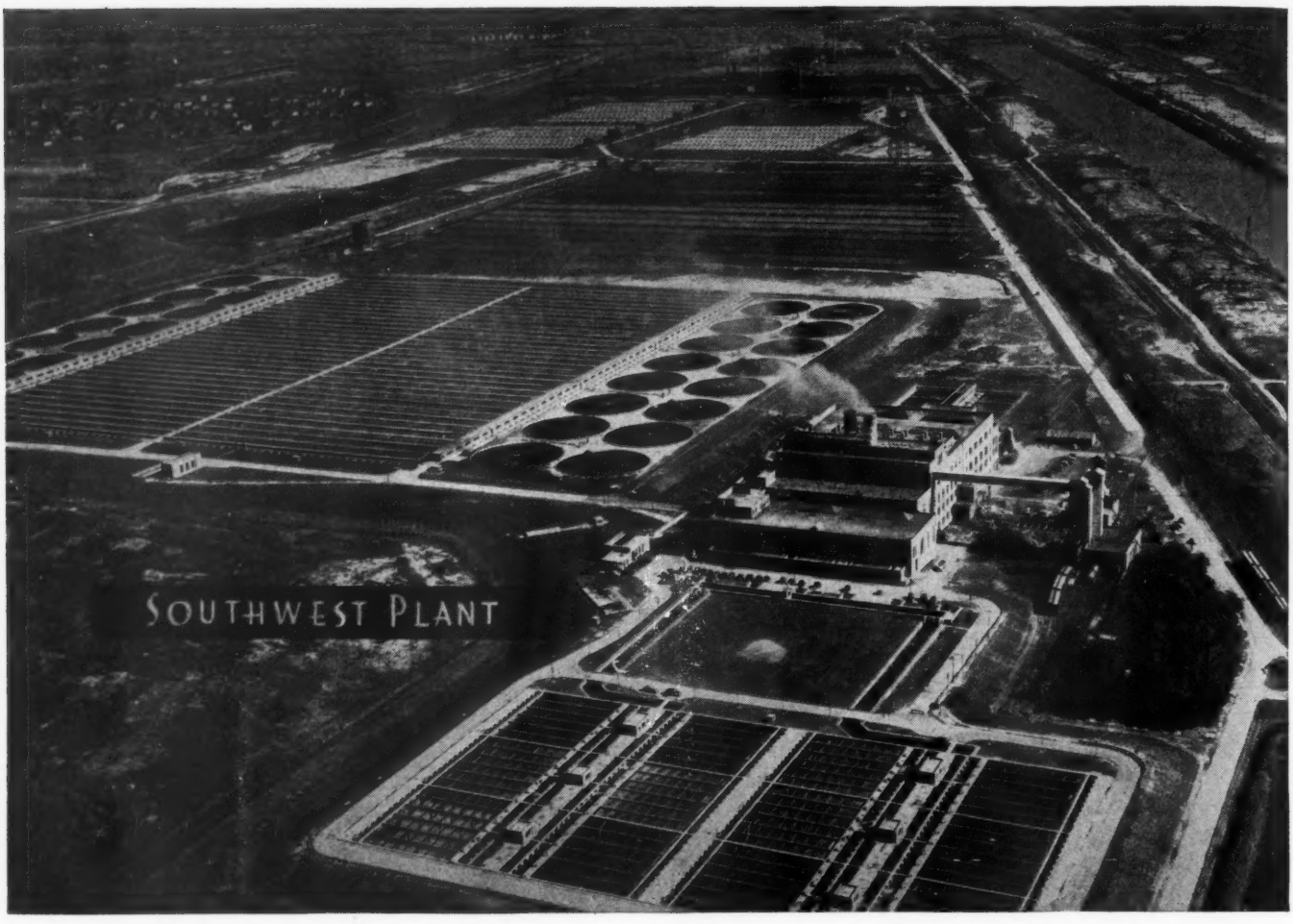
Considerable attention has been paid to the Liberty biofilter, which was the first plant of its type to be installed in the East. This plant was described in the July, 1940, issue of this magazine and a resume of the first three months of operation was reported in the October, 1940, issue. It has been operating this summer under the direction of Messrs. Lawrence and Eichenauer of Liberty and the results are of much interest.

During the months of June, July and August of the 1941 summer, the average removal of BOD was 98%, according to local records which check closely with those of the State Department of Health, which has been keeping a close check on the operation of the plant. At Liberty, all results are based on raw sewage samples composited from 8 A.M. to 2 P.M. and on effluent samples composited from 9 A.M. to 3 P.M. It is believed that the results obtained by this method give higher raw sewage and higher effluent BOD's than 24-hour composites would give, but that the two are closely comparable. The characteristics of the sewage strengths and volumes throughout the 24 hours are well known.

Since Liberty is a summer resort, the summer flows are greater and the sewage is stronger than during the remainder of the year. Averages for June, July and August show the raw sewage to have a BOD of 441 ppm., the effluent of the secondary clarifier to have a BOD of 22 and the final effluent to have a BOD of slightly less than 9 ppm. During the three months, the highest effluent BOD was 13.5, while the lowest was 5; the highest suspended solids was 20 which occurred only once (the next highest was 12) and the lowest was 1.

During the previous winter, the plant was operated as a straight trickling filter, during which time the effluent averaged 44 ppm. BOD and 22 ppm. of suspended solids.

We hope to present in an early issue a complete resume of operating results for the first full year.



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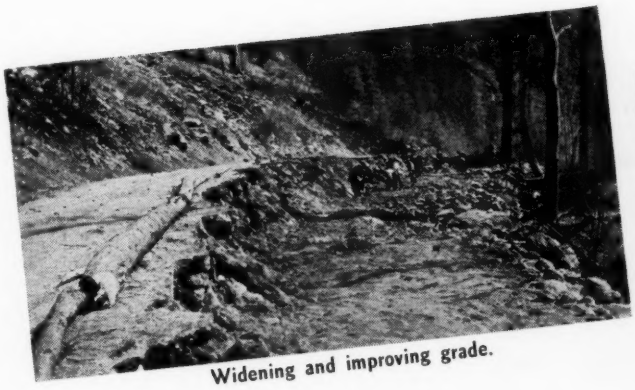
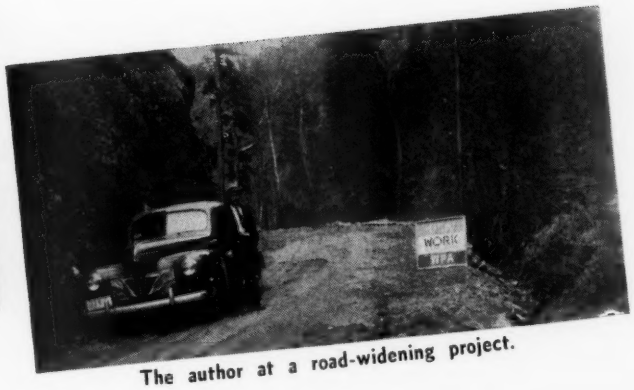


Widening and improving grade.



The author at a road-widening project.

Utilizing WPA Labor During Winter Months

Crews of 10 to 25 men, totaling about 150, used for graveling roads, improving line and grade with hand shovel and wheelbarrow, and other jobs on the 600 miles of county roads.

By H. H. BENSON
County Surveyor, Ravalli County, Montana

RAVALLI COUNTY has a population of about 15,000, which includes an influx, during the past five or six years, of about 3,000 from the drougth areas of eastern Montana and the Dakotas. As this is predominantly an irrigated agricultural country there is considerable unemployment during the winter months, due to low farm wages and seasonal work, resulting in the assignment of 200 to 250 men and women to WPA work. Of this number it is usually necessary to provide work on county-wide WPA road projects for about 150 men. While the work is carried out on a somewhat lesser scale than that on the Grand Coulee Dam, some might be interested to know what is being done with WPA labor "out in the sticks."

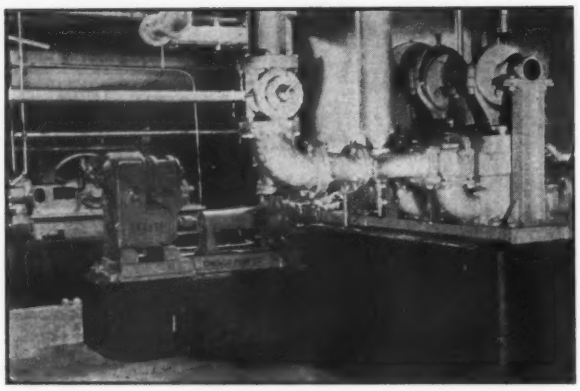
This country is approximately 80 miles long north and south by about 25 miles east and west, bisected north and south by the Bitter Root river with most of the farming area and population in the northern half of the country. The 600 miles of county roads are made up of parallel north and south roads with east and west "side roads" reaching into the foothills to the borders of the farm lands, some of the roads traversing rough hilly terrain. The soil formation is widely varied, including gumbo, light clay, gravel, boulders, and, in a few localities, solid granite. Most of the county roads were located back in the horse and buggy days without much consideration for grade or alignment. With the establishment of rural mail routes and operation of school buses made necessary by consolidation of the rural and town schools, many miles of roads had reached a state of functional obsolescence which permitted utilization of WPA labor in the winter months.

Team haul graveling unit.

The county, as sponsor, is required to contribute a minimum of 25% of the total estimated cost of the projects, the actual amount usually exceeding that. Under the present project totaling $139,679, of which $99,356 is Federal and $40,323 is sponsored, the sponsor's contribution to date is over 34% of a total expenditure of $109,560. The sponsor's contribution is in the form of supervision, gang foremen, transportation of men, material and equipment.

It has been found that best results could be obtained by using non-WPA foremen and dividing the men into small crews of from 10 to 25 men to each unit.

(Continued on page 22)



Two units which pump heavy sludge solids to digestion tanks

Sewage Sludge

By DAVID BACKMEYER
Plant Superintendent

IT IS ALWAYS interesting to review operation results for a period of several months, and endeavor to find reasons for some of the more unusual conditions encountered. This is particularly true when a sewage treatment plant is first started, and many unforeseen conditions arise during the first several months of operation. In the following report an effort is made to show what operation results were obtained during the first nine months of sewage sludge digestion at the Marion, Indiana, treatment plant and what specific conditions were responsible for these results.

The Marion sewage treatment plant, designed and constructed under the supervision of Consoer, Townsend, and Quinlan, consulting engineers, was completed in June, 1940, at a total cost of $470,000. The plant is of the activated sludge type, with separate sludge digestion and vacuum filtration of the digested sludge. Three Climax gas engines utilize the sewage gas produced. This is one of the few plants designed for dual disposal. Provision has been made for the introduction of ground garbage to the raw sewage wet-well beyond the sewage screens, from where it is pumped with the raw sewage to the grit chambers prior to pre-aeration and settling.

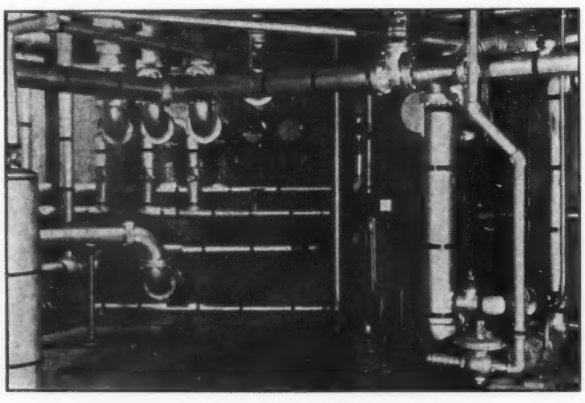
Primary treatment consists of plain sedimentation in three rectangular settling tanks, settled solids being removed by Chain Belt equipment. The capacity of the three tanks is sufficient to permit one hour and fifty minutes detention for a flow of 4 m.g.d. All primary sludge is drawn by gravity from the sludge hoppers through a telescopic valve into a storage well of 3,500 gallons capacity, from which it flows by gravity to a double-cylinder plunger pump, which transfers it to the digesters at 150 gallons per minute.

There are two sludge digestion tanks identical in design, 65 feet in diameter and 24 feet working side wall depth, the bottoms sloping 6 ft. 4 in. to the center. Both digesters have Pacific Flush Tank floating covers with insulated roofs. The capacity of each tank is 83,600 cubic feet, providing a total capacity of 6.25 cubic feet per capita for the actual present resident population. B.O.D. results for the first three months of 1941 show that the raw sewage treated represents an equivalent population of 32,530, on which basis the digestion capacity is 5.1 cubic feet per capita.

The gas generated is piped from the domes of the floating covers through a 4-inch line. Meters are installed for the measurement of the gas wasted as well as that used in gas engines and a gas-fired hot-water boiler of 500,000 B.t.u. capacity. Excess sewage gas may be stored up to 50 pounds per square inch pressure in a cylindrical tank of 5,000 cubic feet capacity.

The digestion tanks are heated by hot water which is circulated through eight 2½ in. wrought iron heating coils in each tank. Meters measure the volume of hot water circulated through the coils, and recording thermometers indicate the temperature of the water as it enters and leaves the digestion tanks. When the air temperature is above 15° F., circulating water at 122° F. will maintain the primary digester at 94° with 85 gallons per minute flowing through the coils. The water returns to the gas engine heat exchanger at 115°.

Supernatant is drawn by gravity to a wet-well, from which it can be pumped to the raw sewage at any desired rate. Three 6″ lines provide a means of withdrawing sludge or supernatant at elevations of 12 feet, 15.5 feet, and 19 feet from the tank bottoms. Digested sludge may be drawn from the bottom and center of either tank and may be transferred from one to the other if desired. Supernatant and sludge lines are tapped for sampling with 2″ pipes to permit the checking of sludge concentrations at any of the several elevations.

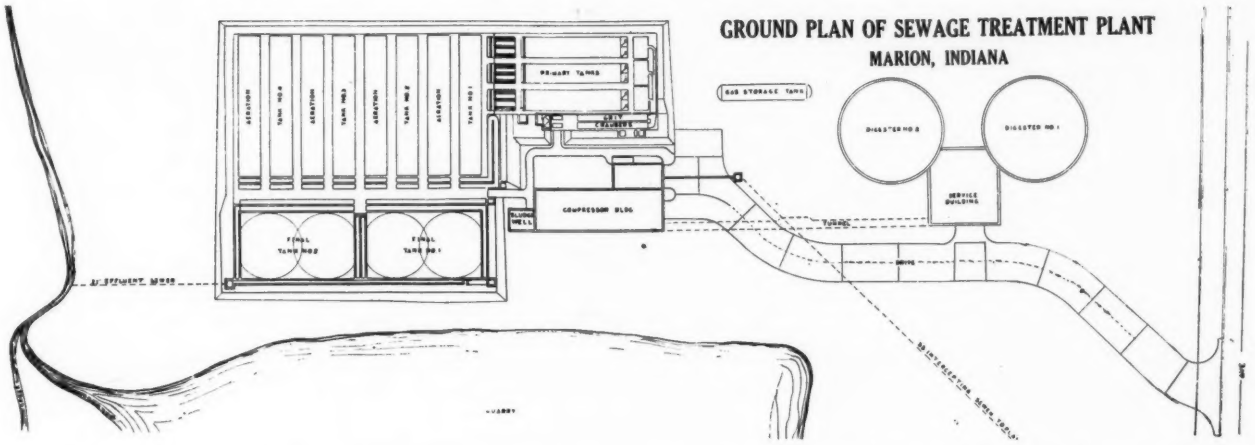


Control valves for sludge digestion tank

Round-up of officials just before plant completion

Digestion at Marion, Indiana

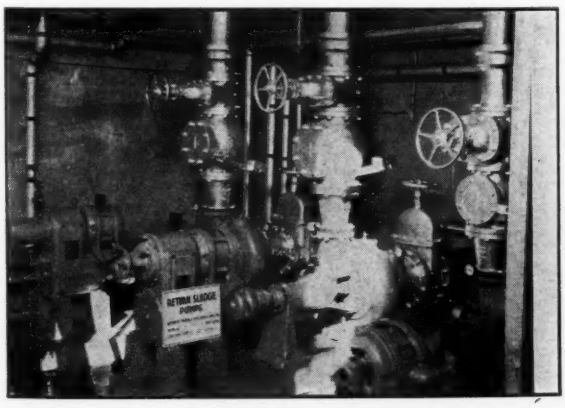
Results obtained during the first nine months of operation of this activated sludge, digestion, vacuum filtration plant



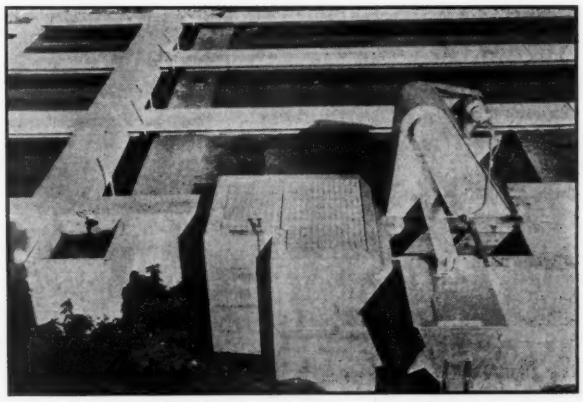
On July 7, 1940, the first sludge from the primary tanks was pumped into the primary digester, which was partially full of water that had been used for testing the floating cover. Solids loadings for the first 24 days averaged 4,260 pounds of dry solids per day. The most digested portion of the primary digestion tank was transferred to the secondary when necessary.

The temperature of the primary digester during the first two weeks was 68°. In order to promote a progressive digestion of the sludge solids as they were added, it was decided to increase the temperature 15 to 20 degrees. The gas boiler was fired with utility gas for 11 successive days beginning July 20, after which the gas engines were put into service, and the heat from them was substituted for the boiler heat. The cost of the boiler heat, based on a consumption of 300 cubic feet per hour of 1,000 B.t.u. gas, was $35.64 for the 11-day period. At the end of July the temperature of the primary digester was 89°, and of the secondary 85°. On November 1 the temperature of both primary and secondary was 95°. After November 11 no hot water was circulated in the coils of the secondary tank, and the temperature in this fell to 88° by December 1 and 86° by January 1.

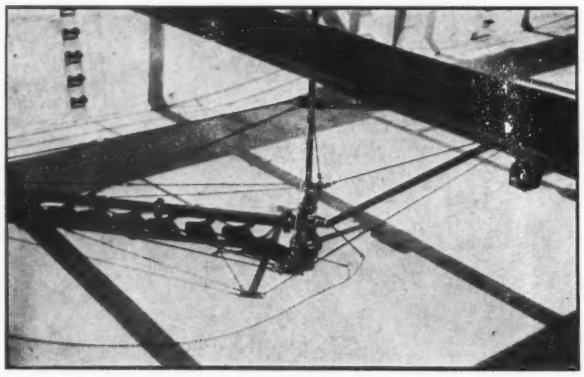
The hydrogen-ion concentration of the digestion system was watched with interest during the first several weeks, and an effort was made to maintain a pH of 6.8 or higher during this time. It was hoped that foaming troubles might be held to a minimum by controlling from the beginning both the temperature and the alkalinity-acidity balance. The probability of a repetition of a previous experience with a foaming digestion tank was not anticipated with much pleasure by the writer. The pH remained on the acid side during the first two weeks of operation, and lime was added to the primary sludge in dosings of 900 pounds per day to raise the pH to 7.0. After several days the pH did increase to the neutral point, but a



Return sludge pumps



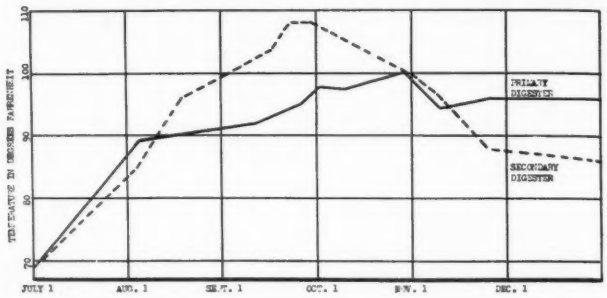
Scum troughs and grit removal mechanism



One of four collectors which remove settled activated sludge from final settling tanks

week later an acid condition again developed which lowered the pH to 6.3. Although several tons more lime was added, the neutral point was not reached for a 20-day period. On August 15, 39 days after the first raw sludge was pumped into the digester, it became evident that a foaming condition was in progress and three days later the floating cover was riding on a blanket of foam 3 feet thick, and no supernatant could be drawn from either of the two top elevations of the digester. Thanks to the ample design in the digestion capacity, it was possible to let the foaming tank rest for two weeks, during which time no sludge was added to or withdrawn from the tank. At the end of this period the foaming had practically cleared up and primary sludge solids were again added in the usual manner.

The first part of Graph No. 2 shows the "splurge" which took place in the gas production during the foaming period. From the 47th to the 52nd day of operation a total of 932,000 cubic feet of gas was generated in this boiling tank. The primary sludge analysis record indicates that a total of 144,000 pounds of volatile solids had been added to the primary digester previous to the rapid increase in gas production on August 15. Ten days after the foaming had stopped,

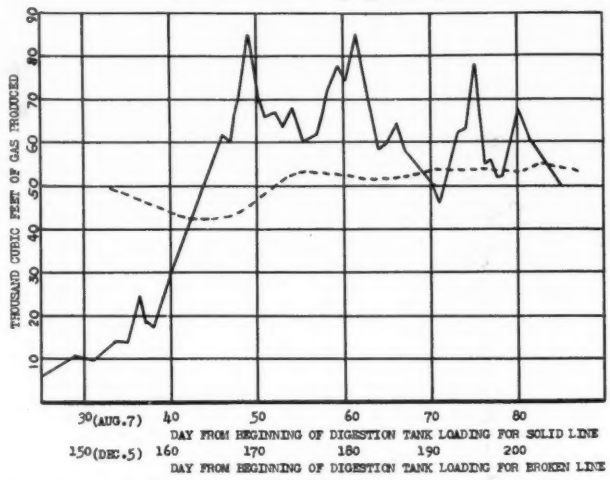


Graph No. 1—Temperature range of digestion tanks

the pH of the tank had increased to 7.7 and has always remained on the alkaline side since that time.

The broken line of Graph No. 2 represents the gas production for the fifth and sixth months' operation. Later records indicate the volumes of gas produced during these months may be considered typical of the general operation. This amount of sewage gas has been sufficient to pump all of the raw sewage, furnish

(Continud on page 31)

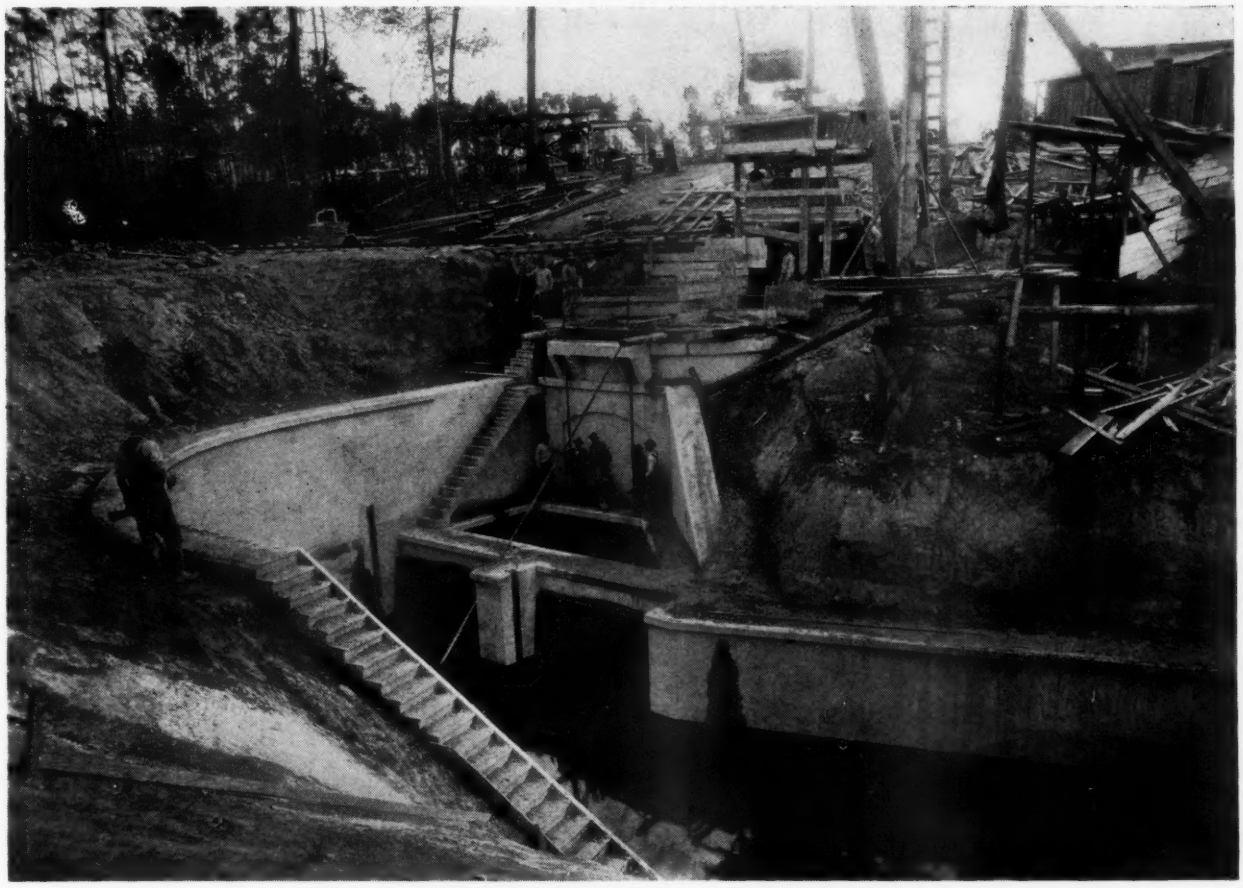


Graph No. 2—Gas production during two periods of digester operation.

TABLE NO. 1

Gas Production and Solids Loadings

Date (8 Days)	Pounds of volatile raw sludge, 8 Days	Gas in cu. ft. 8 Days	Cu. ft. gas per lb. vol. added	Cu. ft. gas per capita actual pop. 27,600	Cu. ft. gas per capita equiv. pop. 32,500	Wt. removed as sewer gas (pounds)	Percent of original volatile removed as sewer gas
Sept. 1.....	44,700	579,000	12.9	2.62	2.23	37,600	84.0
9.....	44,690	445,000	10.0	2.02	1.71	28,900	64.6
17.....	41,250	482,000	11.7	2.18	1.85	30,700	74.5
25.....	36,912	441,000	11.9	2.00	1.69	28,700	77.7
Oct. 3.....	52,134	482,000	9.2	2.18	1.85	31,300	60.1
11.....	41,408	452,000	10.8	2.05	1.74	29,400	70.2
19.....	57,990	418,000	7.2	1.89	1.61	27,200	47.0
27.....	67,015	396,000	5.9	1.79	1.52	25,800	38.5
Nov. 4.....	57,735	404,000	7.0	1.83	1.55	26,250	45.6
12.....	46,350	345,000	7.5	1.56	1.33	22,410	48.3
20.....	43,290	390,000	9.0	1.76	1.50	25,400	58.7
28.....	43,270	411,000	9.5	1.86	1.58	26,700	61.9
Dec. 6.....	57,310	419,000	7.3	1.89	1.61	27,200	47.4
14.....	55,850	429,000	7.7	1.93	1.65	27,900	49.2
22.....	49,880	430,000	8.6	1.93	1.66	27,900	56.0
30.....	40,540	406,600	10.0	1.84	1.56	26,300	65.0
Jan. 5.....	41,710	405,800	9.7	1.84	1.56	26,400	63.4
13.....	51,260	396,400	7.7	1.80	1.53	25,800	50.4
21.....	35,080	400,600	11.4	1.82	1.54	26,000	74.0
29.....	37,520	416,500	11.1	1.89	1.60	27,100	72.2
Feb. 6.....	35,110	480,900	13.7	2.18	1.85	31,300	9.2
14.....	35,870	425,900	11.9	1.93	1.64	27,700	77.2
22.....	38,520	455,100	11.8	2.06	1.75	29,500	76.6
Mar. 2.....	46,560	468,600	10.1	2.12	1.80	30,500	65.6
10.....	31,680	428,000	13.5	1.93	1.64	27,800	90.8
18.....	37,590	452,900	12.1	2.06	1.74	29,300	77.9
26.....	44,064	482,900	11.0	2.18	1.86	31,400	71.2
Average	45,010	435,000	10.0	1.96	1.67	24,535	65.1



Inlet forebay and shaft, Edisto-Ashley River tunnel

Construction of Charleston's Edisto-Goose Creek Tunnel

Methods employed in constructing 23 miles of 7-foot tunnel by day labor rather than contract

Tunnel heading before trimming

CHARLESTON, S. C., after experiencing two serious water shortages while being supplied with water by a private company, in 1917 purchased that company's plant, and placed J. E. Gibson in charge as Manager and Engineer, which position he still holds. The supply at that time was from a storage reservoir on Goose Creek with a normal yield of 6.5 mgd—5.5 mgd in dry years. To supplement this supply, water has been brought to this reservoir from the Edisto river, which has a drainage area of 2,476 sq. mi. above the intake and a minimum monthly average flow of 450 mgd and minimum daily flow of 350 mgd.

The Edisto river intake is about 35 miles from the city, and 23 miles from the pumping station and purification plant. At the intake, the low water elevation of the river is 22.3 ft. above mean sea level. The ultimate plan called for a tunnel from intake to Goose Creek reservoir; but at first, in 1928, only 4½ miles of this was built, diverting water from the Edisto into the upper reaches of Ashley river (which flows by Charleston), down which it flowed to a dam 19 miles from the city, from which it was pumped over a divide 26 ft. high into Goose Creek reservoir during times of drought.

In 1936 the West Virginia Pulp & Paper Co. proposed to establish a paper mill near Charleston, provided the city would furnish it with the necessary water by means of a tunnel from the Edisto river, and the Public Works Commission contracted to do so, water to be available by July 1, 1937, or 12 mos. and 11 days after the closing of the contract. This meant driving 18.61 miles of 7 ft. diameter tunnel through marl formation 40 ft. below mean sea level.

Junction of marl and concrete lining of shaft above marl. No spalling or squeezing after six months.

It was estimated that the time required for preparing plans, period of advertising, investigation of the ground by contractors and closing of contracts would be at least 90 days. The time allowed for construction was short and it was believed that most of this 90 days could be saved if the Commissioners of Public Works constructed the tunnel themselves. In fact, a tunnel expert, Robert E. Parker, was employed as construction superintendent and began clearing shaft sites several days before the final closing of the contract, and the tunnel was completed in a little less than 10 months.

The cost of this tunnel was $976,206, including engineering, lands, right-of-way, inspection, materials, labor and equipment. (This was reduced slightly by salvaging the machinery.) This averages a little less than $10 a foot. The 4.5-mile section built by contract in 1928-29 had cost $16.32 a foot, calculated on a similar basis. Workmen's compensation insurance was carried by the department, with a saving of something over $50,000 in cost for insurance alone. The only serious injury on the entire job was the loss by one workman of the first joint from four fingers of his left hand.

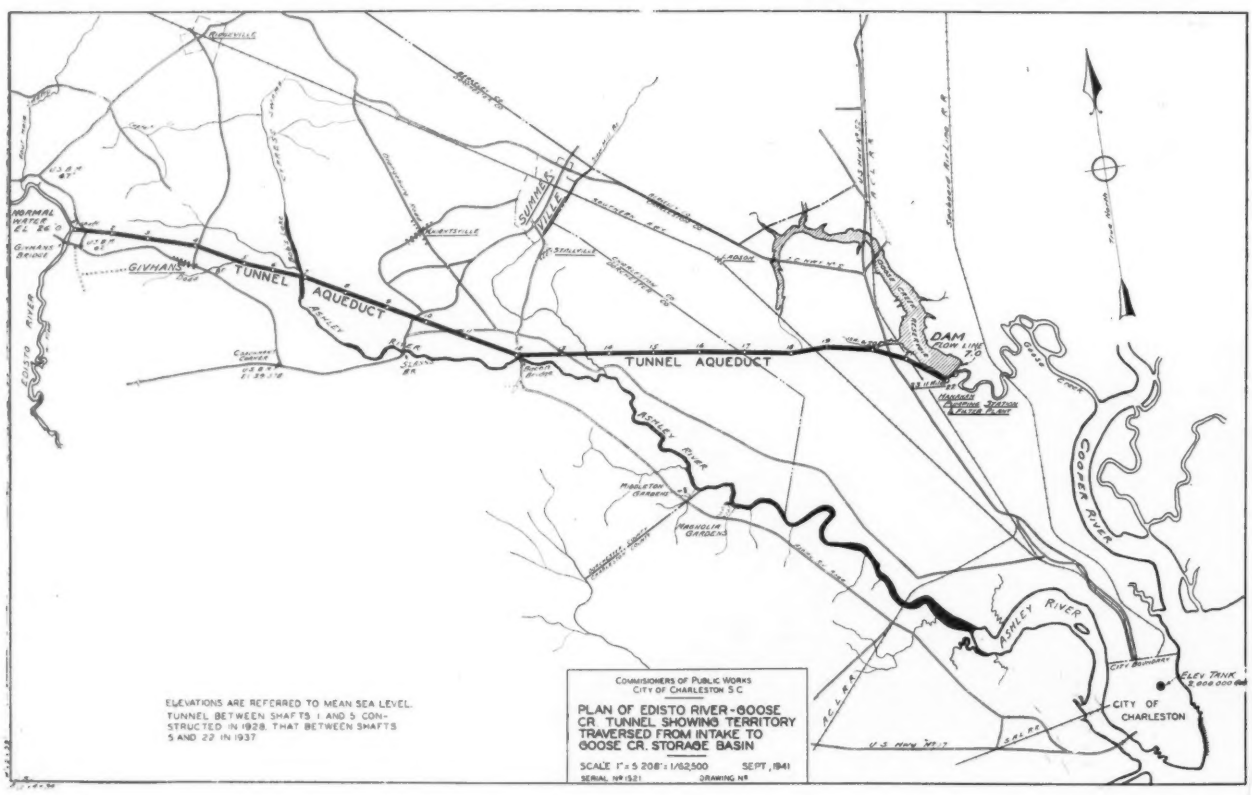
The tunnel is of modified horse-shoe shape, with a total fall of 18 ft. in 23.1 miles. Its capacity by gravity is 55 mgd, which can be increased to 75 mgd by pumping the outlet shaft down to elevation—13. It is so located as to lie through marl for its entire length, with a minimum thickness of 20 feet of hard marl above the intrados at all points. It is unlined, an inspection of the first 4½ miles after over 7 years of use having shown no deterioration, with less than a half-yard of material sloughed off the surface for the entire length. The marl can easily be cut with a sharp tool when first exposed but soon after becomes very hard. During construction, infiltration of water into the tunnel was less than ½ gal. per 24 hr. per lin. ft.

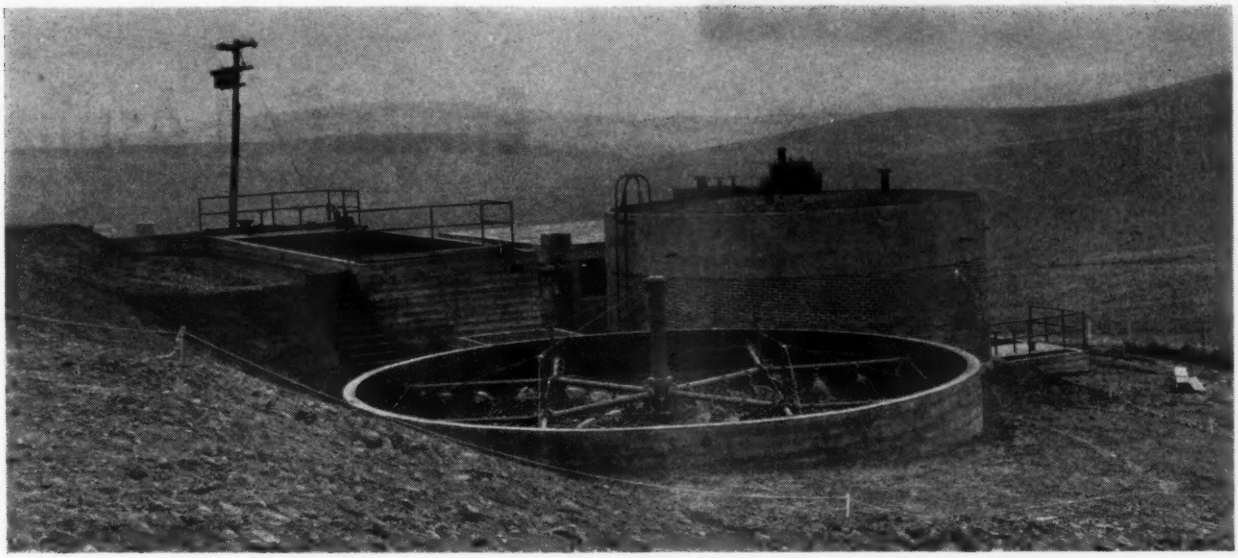
When water was first run through the aqueduct there was a measurable increase of alkalinity from the intake to the outlet; but at present there is little if any such increase. Presumably the surface of the tunnel contained much bruised and disintegrated marl which rapidly went into solution; but when this had been dissolved, practically all such action ceased.

Before finally locating the tunnel, 5″ wells were drilled to and into the marl, one about 300 ft. and another 2,500 ft. from each proposed shaft location. These were drilled directly on the line of the tunnel and used to check alignment and aid in ventilation during construction; after which they were filled with concrete in which was cast a 2″ pipe, with a U-bend on top, to serve as a permanent vent.

Seventeen shafts were built about 6,000 ft. apart. The overburden on the marl varied from 6 ft. at some shafts to 30 ft. Where it was less than 16 ft. the shaft

(Continued on page 35)


TUNNEL AQUEDUCT
TUNNEL AQUEDUCT
DAM
ASHLEY RIVER
COOPER RIVER
CITY OF CHARLESTON
ELEVATIONS ARE REFERRED TO MEAN SEA LEVEL.
TUNNEL BETWEEN SHAFTS 1 AND 5 CONSTRUCTED IN 1928. THAT BETWEEN SHAFTS 5 AND 22 IN 1937.
COMMISIONERS OF PUBLIC WORKS
CITY OF CHARLESTON S.C.
PLAN OF EDISTO RIVER-GOOSE CR. TUNNEL SHOWING TERRITORY TRAVERSED FROM INTAKE TO GOOSE CR. STORAGE BASIN
SCALE 1″=5 208′=1/62,500
SEPT., 1941



General view of sewage treatment plant at Pendleton, Ore., airfield.

Sewage Treatment Plant for an Airfield

The Government is providing high-grade treatment plants, in contrast to the makeshifts at the camps of World War No. 1

THE recently completed sewage treatment plant for Pendleton Field, Oregon, consists of a primary settling tank, a high-capacity filter, a secondary settling tank, a sludge digestion tank, sludge drying beds, a control house and office building and provision for pre- or post-chlorination. The plant is designed to treat an ultimate flow of about 325,000 gallons per day, or about three times the flow of sewage as of Sept. 1.

Because of its location on a hillside, as shown in the illustrations herewith, ample head was available and pumping was not necessary. The details of the units are as follows:

Primary Clarifier. — This is a rectangular tank, equipped with Link-Belt apparatus for sludge collection and removal. The tank is 48 ft. long, 13 ft. 4 ins. wide and 10 ft. 3 ins. total depth, providing a detention period of 3 hours for a flow of 325,000 gallons.

Another view of the treatment plant.

Trickling Filter.—This is an Aero-filter with 8 distributing arms. The diameter is 34 ft. 4 ins., and the depth is 8 ft. 4 ins. The rate of application of sewage to the surface, when the flow is 325,000 gpd., will approximate 16 million gallons per acre per day, and the loading, on the basis of a raw sewage strength of 300 p.p.m. B.O.D., without allowance for removal in the primary tank, is about 3 pounds per cubic yard.

Secondary Clarifier.—The secondary settling tank also is rectangular and equipped with Link-Belt sludge collectors. It is 42 ft. long, 13 ft. 6 ins. wide and 8 ft. 9 ins. total depth.

Sludge Digester.—The digester is of standard type, circular, with brick veneer insulation, and is 29 ft. in diameter and 26 ft. 5 ins. total depth. Based on a load of 4,000 population, about 3 cu. ft. per person digestion capacity is provided.

Sludge Drying Beds. — There are three uncovered sludge drying beds, each 20 ft. wide and 50 ft. 3 ins. long, giving a total area of about 3,000 square feet. These are located on a contour up the hill from the plant, the sludge being pumped to them.

Control and Office Building.—This is a reinforced concrete building of modern design, 21 ft. 4 ins. wide by 26 ft. 4 ins. long. It houses all equipment, and provides laboratory and office space.

Chlorination. — Unusual flexibility is provided in the arrangements for chlorination. Chlorine may be applied to the incoming raw sewage, to the effluent from the primary clarifier before application to the filter, or to the effluent from the secondary clarifier.

Stabilized base material partially spread to 2" thickness to dehydrate

Emulsified Asphalt

By BEN T. COLLIER

County Engineer, Coahoma County, Miss.

COAHOMA COUNTY, Mississippi, lies in what is commonly called the Mississippi Delta. The soil is entirely an alluvial deposit, and while fine for farming, is in some instances a nightmare for road building. The entire region is now protected by levees and does not overflow, but before these levees were constructed, the land was covered almost every year by the flood-waters of the Mississippi river, which left deposits varying from a sandy soil which makes a very fair subgrade (A-2) to the vilest gumbo (A-7) with an unbelievable shrinkage factor. These types of soils are superimposed upon each other, sometimes with the sand on top and sometimes the clay. The soil on one side of a stream, generally a bayou, may be the extreme from that on the other. The general topography is flat, roughly paralleling the flood stage of the river, with ground water within a few feet of the surface, so drainage is a problem.

In the summer of 1939, the county constructed eight miles of road with the help of Federal Aid Secondary funds, using a bituminous stabilized base, which has proved so satisfactory under such trying conditions that the State Highway Department, which participated in the construction, has this year set up several similar projects. The construction seems worthy of description, because performance is the goal sought after, and this road has shown not one square yard of failure to date, though the first winter subjected it to temperatures below zero, which are unusual for this section.

The Bureau of Public Roads, after thorough investigation of local conditions, allowed many deviations from their usual requirements in order to bring the cost within reasonable limits for a secondary farm-to-market road. For instance, the original gravel surface of the road was smoothed to a good riding surface with a blade grader, without adhering to mathematical grade lines, and the finished surface followed this grade. The results were excellent.

The work was let by contract. The details of construction were as follows: After blading the road to a smooth riding surface, the material for a width of 20 feet was scarified to loosen the gravel surface. A windrow was made of the gravel (which was about one inch thick) and the subgrade material, whatever its character, sufficient in amount to make a stabilized base of 6 inches compacted thickness; the amount necessary varying with the type of subgrade earth, an average allowance of about 25% being made for shrinkage. The windrowed material, containing gravel and sub-grade material, was tested by screens, and if the windrow contained more than 25% of material passing the 200-mesh sieve, sand was added in sufficient quantity to bring the contents of the windrow to a minimum of 20% to 25% passing the 200-mesh, it having been found that this proportion allowed the use of the most economical amount of bituminous material for stabilization.

The tested windrow was made uniform in size by drawing an equalizer over it. The equalizer was a home-made device, with flared sides and an adjustable tailgate aperture, which was drawn by a tractor. This proved very effective.

The windrow was now ready for mixing with the bituminous material, emulsified asphalt, mixing grade being used. A Woods mixer of the pug-mill type was drawn over the windrow, and in it the aggregate material was mixed with the asphalt and a sufficient quantity of mixing water for proper manipulation, field laboratory tests being made to determine the optimum moisture content at which compaction could best be accomplished. After being mixed, the material was deposited by the mixer in a windrow on the subgrade.

The windrow was spread to a uniform thickness by patrol graders, and sheepsfoot rollers were used as soon as the optimum moisture content had been reached by drying out. This stabilized base was finished with a rubber-tired roller and a patrol grader working together, and then given a final rolling with a 7-ton tandem roller. Approximately 3 gallons of emulsified asphalt per square yard of 6-inch compacted thickness was used in the base.

Six-inch stabilized base after compaction

Coahoma County road after two years' service

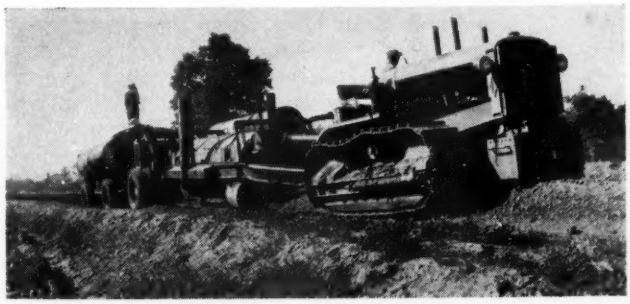
Stabilized Base Construction

Method of constructing eight miles in 1939 which proved so satisfactory that several similar projects were constructed this year

Even in hot summer weather, the 6-inch compacted base was slow in curing, and numerous spots would show alligator cracking which often took three weeks or more to solidify under sprinkling and rolling. It was not deemed advisable to prime this base until the moisture content was below 5%, and the maintenance of the base under traffic was quite expensive to the contractor, as much sprinkling and blading were required. A method to overcome this objection was worked out by blading and compacting the stabilized windrow into place in layers about two inches thick. Many hard lumps of stabilized material were developed by allowing the windrow to crust over while the successive layers were drying out, but in all cases these lumps were easily broken up and consolidated with the bladed material by a very small amount of sprinkling and rolling. With the moisture thus evaporated from the bottom, the priming could be done almost immediately. In view of the satisfactory results obtained by this method, the manufacturer of the emulsified asphalt used (the American Bitumuls Co.) now recommends this procedure.

Another valuable construction detail was discovered on this job also. Where the thickness on the inside of a curve was found deficient due to blading, the contractor was required to remove the entire base for 500 feet after it had hardened for over a month. Additional subgrade material was scarified and sand added, the necessary amounts of asphalt and water were sprinkled on, and the whole section remixed with a blade grader. After compaction, this section showed as good density as any section and has shown no signs of deterioration up to the present. This feature and the method of consolidation were considered the most valuable lessons learned during the construction.

After the base had lost sufficient moisture and was hard and firm, it was primed with a medium curing asphalt (Miss. State Highway Specifications MC 1-S). After the prime had penetrated, a hot application of 0.4 gallon per square yard of asphalt cement (Miss. State Highway Specifications AC 20) was applied, and covered with ¾-inch crushed blast furnace slag in the amount of 0.54 cubic foot per square yard. This single surface treatment appeared rather harsh and noisy under traffic at first, but has since worked out to an unusually smooth yet non-skid surface. The base was stabilized and primed to a width of twenty feet and the wearing surface constructed eighteen feet wide.



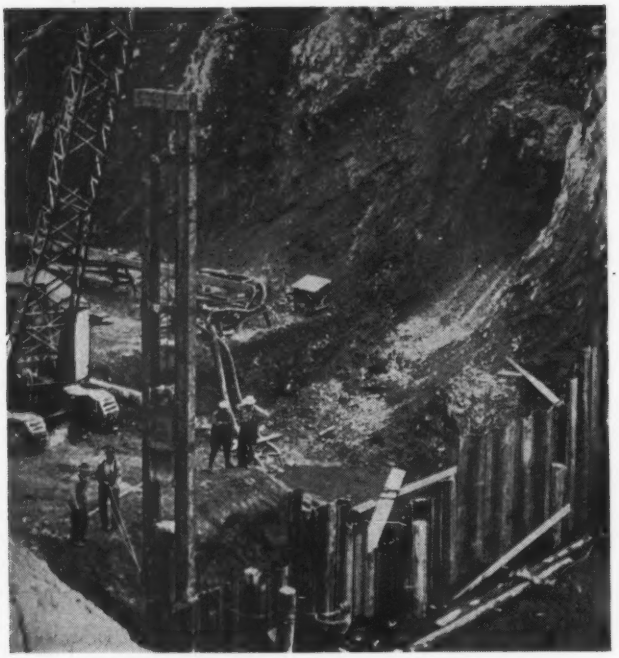
A Wood mixer on a Coahoma Co. road

Final 2" thickness of stabilized base material being spread and compacted

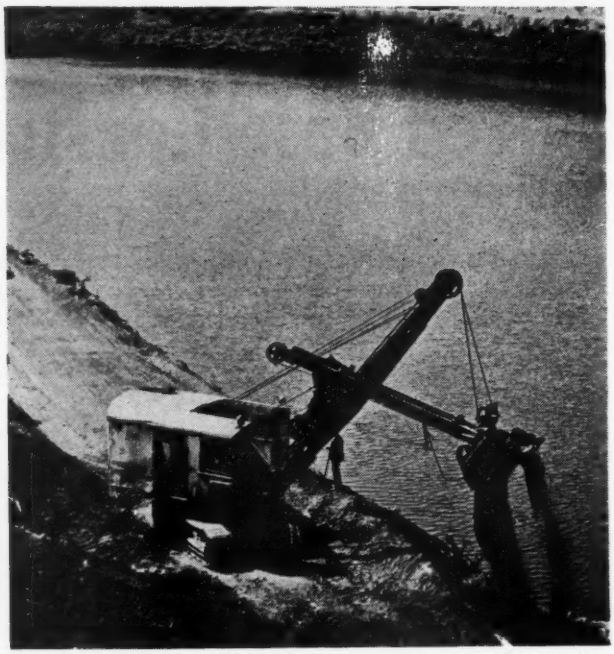
The total contract price, not including bridges, was $72,156 for a distance of 8 miles, or $9,019.50 per mile. The State Highway Department furnished laboratory control and engineering services, under the supervision of the county engineer acting as project engineer. The equipment used on this work included a sheepsfoot roller drawn by an International pneumatic-tired industrial tractor; a Caterpillar tandem drive patrol grader; a Kinney distributor for spreading the hot asphalt; an Allis-Chalmers tractor, and a Woods mixer. Power for the last was supplied by the tractor through the propeller shaft. The asphalt emulsion and water were supplied to the mixer from a trailer tank, which was replenished from trucks that come alongside and discharge without stopping the progress of the mixer. The average daily output of the mixer was approximately 6,000 sq. yd. of base 20 ft. wide and 6 in. thick.

Coahoma County has also constructed another project 10 miles long, using similar construction but with a base thickness of four inches. The results obtained from these stabilization jobs are believed to be more satisfactory than from any other type of secondary road construction so far used by this county.

It might appear that this article is describing an old project which has lost its current interest, but elapsed time is the only true criterion of the value of any highway construction. To be of interest the road must be recent enough to be within the modern trend but old enough to have proven its ability to give long and satisfactory service.



Driving sheet piling for dike core at lower end of Lake Champlain. This dike will be built to a maximum height of 44 ft.



Constructing a 20-ft. road along Lake Champlain for bringing equipment to dam. Later these roads, 20 miles long, will be used for maintenance

Million Dollar Improvements for Everett Water Supply

SUPPLYING Everett, Washington, with sufficient water to meet normal needs plus the increased demands of stepped-up industries and airport construction calls for many improvements to its supply system. These improvements, involving more than a million dollars of expenditures, are now going forward under one of the largest Work Projects Administration undertakings of its type in the State.

Work on this undertaking was begun in July of 1939 with funds provided by WPA in the amount of $879,141. Everett is contributing $237,702 for equipment, materials and other non-labor costs not met by the WPA allocation.

The present water supply of Everett is obtained from Lake Chaplain, which is located approximately 25 miles east of the city limits, and is fed by natural springs and a 7,000-foot diversion tunnel from the Sultan river. The lake's present storage capacity is 1,450,000,000 gallons, which is being increased to 4,500,000,000. The present consumption averages 65,000,000 gpd, which must be increased by 20,000,000 gpd to provide for the city's normal growth and the army air base at Snohomish County Airport. The increased storage capacity of the lake plus improvements being made to the supply lines to the city will make it possible to supply 110,000,000 gallons per day, with sufficient storage to carry over the summer's dry period and the corresponding low flow in the Sultan river.

The capacity of Lake Chaplain is being increased by the construction of two dikes or dams, one at each end. The main dike at the south end of the lake will be 815 feet long and have a maximum height of 44 feet. The smaller dam at the north end of the lake will rise to a height of 18 feet.

In the construction of the south dike, heavy steel sheet piling was driven down to hard-pan to prevent seepage. Poor core material was removed and replaced with proper core material. Building of this dike required 60,000 cubic yards of excavation under dike core, hauling and placing of 150,000 cubic yards of rock blanket for the dike, and 1,010 cubic yards of solid rock flume excavation.

Improvements to the tunnel from the river to the lake include the laying of a reinforced concrete floor requiring 1,000 cubic yards of concrete and 5,511 yards of pre-cast wall and arch lining with reinforced grouting.

The capacity of the tunnel is being supplemented by laying a new 60-inch wood-stave pipe line 2,150 feet long from river to lake, requiring 6,500 cubic yards of trench excavation and backfill, and some 3,000 cubic yards of rock riprap on the Sultan river.

Approximately 33,000 linear feet of new 28-inch wood pipe is being laid at various locations along the supply system, requiring more than 600,000 cu. yds. of excavation (of which 325,000 have been completed), the moving and resetting of 50 air valves, and removing 20,000 linear feet of old 28-inch wood stave pipe.

Headquarters for the operator will be constructed at the south end of Lake Chaplain and will require the clearing and grubbing of one acre of ground, the construction of the operator's house with a septic tank, and 91,000 ft. of telephone line to the city.

(Continued on page 30)

Typical open ditch. When flow of water is small, pools and potholes in bottom may permit mosquito breeding. A covered pipe would prevent this.

Drainage for Mosquito Control

Many cities and other communities are now carrying on mosquito control, especially those in the vicinity of army and navy camps and posts, or of essential defense establishments. Drainage is perhaps the most important factor in such control work.

MOSQUITOES carry certain diseases — notably malaria, dengue and equine encephalomyelitis, in this country—and in addition are pests of the first order. Because three of their four stages of life are spent in water, drainage is the most important factor in their control. The eggs are laid on the surface of the water; in a couple of days these hatch out into wigglers or larvae; in a week or so these develop into tumblers or pupae; and in a couple more days, these emerge as adult, fully-grown mosquitoes. About 8 or 10 days are required for development from egg to adult for most mosquitoes though there are one or two species that can develop in 5 or 6 days under favorable conditions.

Control methods are of two types—permanent and temporary. Permanent methods include drainage or filling, thus removing the breeding areas. Temporary methods include the application of oil or some other killing medium to the surface of the water. Since oils or larvicides do not persist for more than 2 or 3 days, and the breeding cycle of the mosquito is 8 to 10 days, oiling or larviciding is necessary every 10 days or less. The cost of oiling is considerable, especially the cost of the necessary labor, and its effectiveness may be greatly decreased by rains; therefore drainage is both economical and desirable. Certain low areas may be filled, thus eliminating the need for drainage.

Essentials in Drainage

There are essential differences between drainage for mosquito control and for other purposes, though the same principles apply. The first and most important is that, since mosquitoes require 8 or 10 days for development, it is sufficient to remove standing water within 5 or 6 days. Therefore, large drainage structures are not required; nor, in fact, are they desirable. The reason is that unlined ditches are eroded and potholes formed by heavy storm flows and these potholes form excellent mosquito breeding areas. Lined ditches, unless carefully constructed, also develop areas due to settlement or wash where mosquitoes can lay their eggs and the larvae develop. Deposits of drift also occur, requiring frequent inspection and regular cleaning. Lined ditches, while far superior to unlined ones, still require attention. The ideal ditch removes the water within 5 or 6 days and, once properly constructed, requires no attention thereafter. Ditches, while effective in doing this if properly constructed with a broad V section, require cleaning after every storm. The covered ditch, utilizing a pipe, is far superior for most places.

Types of Drainage Problems

Away from the seacoast, where salt marshes form a special problem, drainage for mosquito control falls into a few broad classifications, as follows: Rainwater

pools; swamps; and seepage areas.

Rainwater Pools.—The objective here is usually met by a small drain of such size that the pool will be emptied within a few days after a rain. An open ditch is suitable, except for the required maintenance after each storm. Either a lined ditch or a covered pipe should be used. With the latter, provision must be made to prevent stoppage by trash.

Swamps.—In swamp drainage the objective is two-fold: To remove the standing water and thereafter the water collecting after each rain; and to lower the ground water level below the swamp surface. With no standing water available on which eggs can be deposited, there will be no mosquito breeding. A relatively small drain is suitable. Generally this will be either a pipe drain or a lined ditch. Because there is generally no debris brought down during or after a rain, a covered pipe is preferable. It should be large enough to carry a fair flow.

Seepage Areas.—In the United States, wet areas formed by the seepage from water bearing strata in the soil are particularly adapted to producing the malaria mosquito (Anopheles quadrimaculatus). Proper control is therefore important. A ditch should be dug about 2 feet back from the point of emergence of the water and deep enough to intercept the flow. A covered drain pipe with open joints is the only satisfactory method of treatment since the soil is usually mucky and soft, and will not stand up, while a lined ditch defeats the purpose for which it is intended. Also, a covered drain prevents damage from animals walking over the area.

Essentials in Covered Drains

A blind or so-called French drain is of no value. Essentials are a clear opening to carry the flow, a true and adequate grade, a free discharge and proper material. A screened opening to prevent the entrance of small animals may be desirable.

Pipe Materials. — Drain tile guaranteed by the manufacturer to meet A.S.T.M. C4-24 Extra Quality Drain Tile Specifications should be used. Extra Quality Drain Tile has a low absorption and a high crushing strength. And in doing any work it is always good practice to use good material.

Support.—A uniform grade is essential, especially where the slope is slight. This can be attained in firm soils by filling the bottom of the trench with about 2 inches of fine gravel or broken stone, ½-inch or smaller. In very soft soils, it is desirable to drive stakes flush with the bottom of the trench at about 6-ft. intervals and nail a 1 x 3 or 2 x 4 to these, setting it at the proper grade and laying the pipe on this. Care in providing a good support for the pipe is an excellent investment.

Backfill.—Where the pipe acts only as a discharge, backfill is not required. In seepage areas and other places where underground water must be intercepted, a pervious backfill is needed. This should generally extend around the pipe and to within a few inches of the ground surface. No set rule can be laid down because local conditions governing the depth of the pipe will vary greatly. A relatively fine backfill is desirable—not coarser than ½-inch.

Depth of Pipe and Cover.—Local conditions determine the depth of pipe, but it should never be so low that a free discharge is impossible, as such construction would prevent the attainment of the purpose for which it was intended, namely, the removal of water. The depth, type or amount of cover will also be determined by local conditions. In some cases, it may be desirable to carry the porous material up to the ground surface, so the drain will act also as a surface water interceptor.

Utilizing WPA Labor During Winter Months

(Continued from page 11)

As it is not practical to transport the men more than 10 or 12 miles to the work and the WPA men are fairly evenly located throughout the county, the work has been well distributed.

One of the principal uses made of WPA labor in winter has been the surfacing of soft or slippery roads. This was done with bank-run gravel, of which there is an abundant supply. Two-yard dump trucks were used in most places, with a few jobs being done with teams and wagons on short hauls. All loading was done by hand, using the old fashioned "muck stick." Naturally the output is not very high—about 6 to 8 cubic yards per man day. The objection to this method of work is that it required more than the 25% sponsor contribution to supply the necessary number of teams and trucks in addition to the number of trucks supplied by the WPA, and we seem unable to obtain enough trucks from the WPA to equalize the expense on the basis of the original project setup, which called for $7.46 per man-month for non-labor Federal funds.

Other winter work carried on consisted of improving the alignment, grade and width of road bed. Normally the winters here are not severe, and this last winter (1940-41) has been unusually mild, with a total of not more than one week of below zero weather and not more than an inch or two of snow. The night temperature was below the freezing point nearly all of the time, but this did not hamper the gravel hauling appreciably as the material was usually dry, with a face of 6 to 15 feet to work into. In some pits the frozen overburden of 12″ to 18″ had to be blasted.

On the cut-and-fill units it is a different story—working against conditions that would have caused a contractor to fold-up, we still had to carry on. Wheelbarrows were used extensively, supplemented in some places by a team with two wagons equipped with dump boards, one wagon being loaded while the other was being dumped. The output naturally was low, about 2½ yards per man day.

The WPA setup has influenced the road program in this county appreciably; a great deal has been accomplished that would not have been done without the help of the WPA, although some of the work could have been done at less cost by using county machinery alone. It has helped the outlying districts immeasurably, perhaps at the expense of the more thickly settled districts where the traffic is heavier and should have hard surfaced roads, the construction of which is done in summer months and requires very little manual labor. The annual road and bridge budget is about $65,000 and naturally the more that is spent on the WPA winter projects, the less there is available for construction and betterments during the summer.

It seems to me that there is entirely too much of the WPA funds used for overhead or administrative purposes, that the "forgotten man" is not getting his just share of the allotted funds, that there is entirely too much inspection, regulation and supervision and that it could be greatly simplified.

Example of differential heaving. Back slope and ledge to the right.

Control of Underground Water — A Discussion of Subdrainage Practice

Fundamental principles and effective details of design and construction learned by examination of a large number of failed subdrains. Location of drains. Pervious backfill.

By M. J. ADAMS

IN the highway experience of the past forty years, there have been too many cases where the mistakes made and the lessons learned therefrom have not been sufficiently publicized, with the result that later, the same mistakes have been made in other localities.

Recently, through a rather unusual sequence of events, a relatively small group of engineers had the opportunity of seeing a large number of failed subdrains opened up for inspection. During these inspections there was, of course, a great deal of discussion, from which resulted a general agreement on certain principles. These principles were then applied by a State Highway Department on a large subdrainage program which has now been through a fall, winter and spring.

This year (1941) the same State Highway Department is putting through a larger drainage correction program. (Reducing maintenance costs by means of subdrainage work and as a preliminary to a resurfacing program.) Other states are adopting on their new construction programs the principles learned last year.

It therefore seems worth while to discuss this whole subject in some detail, for whatever it may be worth to engineers elsewhere.

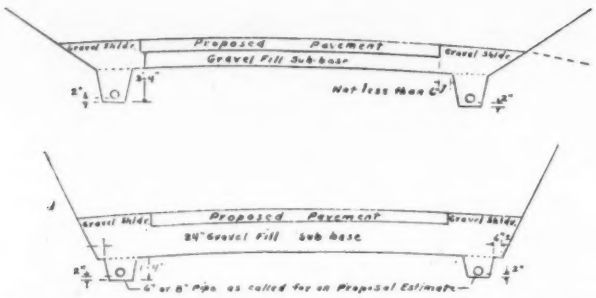
Glossary

So that we will all be talking and thinking about the same things, I am giving a glossary of terms. Some terms such as Underdrain, Sidedrain, Subdrain, have different meanings even in neighboring states. So that the reader will understand the terms as used, I have arbitrarily adopted certain word meanings for the purposes of this discussion.

Water Table.—That elevation, or that point, below which, to any depths with which we are concerned in our highway work, the soil interstices are filled with water. An excavation made below this level will fill with ground water up to the Water Table.

Water-bearing Strata.—This expression is not used to cover a perched water table, above a general water table. It has to do with relatively pervious strata which, due to their location on top of, or between, relatively impervious strata, are carrying always, or only at times, an amount of water all out of proportion to what they would carry, except for their relationship to nearby impervious strata. These water-

Example of differential heaving. Long back slope to the left.



Typical installations of foundation underdrains. Above—in earth cut; below—in rock cut.

bearing strata may be a fraction of an inch or many feet in thickness. They usually have a definite slope; frequently a rather steep slope.

In subdrainage work in this section, we are in general much more concerned with *water-bearing strata* than with *water tables*.

Pervious and Impervious.—The terms *pervious* and *impervious*, as applied to the native soils, should frequently, if not usually, be preceded by the word "relatively." Some gravels which look fairly good on casual inspection, are found to contain enough clay to make them relatively impervious. Some relatively impervious soils (hard pans), given water enough and time enough, will become saturated and flow on slight gradients. The term "pervious," as applied to the borrow backfill placed around and over the subdrain pipe, means free draining in its truest sense.

Underdrain.—An underdrain was originally a subdrain under the pavement. The use of a subdrain under the pavement has practically ceased in this section. The term "underdrain" is still frequently used, but its use covers a practice that is identical with what some mean by the term "sidedrain" and still others by the term "subdrain."

Sidedrain.—This term probably had its widest use when under-the-pavement-drains were being installed, being used to differentiate from that type. The term is still widely used but, if there is a trend, it is toward the wider use of *subdrain*.

Back slope.—This is used to describe a condition where the ground slopes definitely up from a highway. It is ordinarily used as a general expression to give an idea of potential surface or underground water supplies. For example, between Station—and Station—there is a 2000 ft. back slope.

Location of Subdrain With Reference to the Pavement

Because it bears on the question of the location of the proposed subdrain, an analysis should be made of the reasons or needs for its construction. There may be two or three reasons, but one of them may be strong enough to dominate the others. For example, there have been many miles of high type highway constructed in this section, in moderately bad soils, in the construction of which a continuous subdrain has been placed on each side of the pavement. The primary purpose of these subdrains was to insure the most positive drainage of the pervious base under the pavement, and they were built integral with this base and so give it continuous drainage. Being constructed considerably deeper than the base course, they also serve as subdrains; but the primary function is to drain the base course, which fixes the best location as being a few feet outside of the edge of the pavement.

In the case of other new construction projects, there may be equally sound reasons for putting the proposed subdrain under the gutter.

In some cases the primary reason for placing the subdrain may be to reduce traffic hazards, such as icing of the pavement. The largest drainage correction program ever carried out in this section was initiated originally as a de-icing program. It came about in this way: On many state highway sections the maintenance forces were kept busy, at great expense, chopping ice during much of the winter. Efforts to correct these conditions by modern subdrainage methods were so successful that the department went into a much larger program of drainage correction.

To state the problem in the simplest terms, the aim in drainage is to protect the integrity of the pavement. However, more than that is frequently involved. In one case the pavement itself was not seriously affected, but vehicles would break through the saturated and unstable shoulders, causing accidents.

Various factors may affect the decision as to the location of the subdrain on strictly maintenance projects. On heavily traveled roads the single item of maintaining traffic during construction of the drain may outweigh all other factors and cause the placing of the subdrain under the gutter.

Factors Involved in Location of Subdrains

In those soils which cause the greatest drainage difficulties, the ground water curve rises rapidly upon passing a subdrain. It might be thought that in order to give maximum protection to the pavement, the subdrain should be located under the center of the pavement; but this location has been thoroughly tried out, has been found unsuccessful, and has been largely abandoned. While it is true that this location gives the greatest benefit in lowering the ground water curve under the pavement, there are other factors which more than offset this.

A well designed and well constructed subdrain gets the water out of the soil into the drain and conducts it, under control, to a safe outlet. However, we have much to learn about the design and construction of subdrains, and experience has shown that they do fail to function at times. To locate a subdrain under the pavement seems like inviting trouble for, if anything goes wrong, the drain is inaccessible and there is nothing you can do about it except try again in another location. A location under the shoulder at the edge of the pavement is more accessible and since it is also advantageous in controlling the ground water curve, it is much better than under the pavement; but a few feet from the pavement edge should be better. This is advisable so that the excavation for the subdrain will not weaken the soil structure supporting the pavement; also because if placed too close, the

A two-lane concrete pavement with water coming through the joints and cracks and running down on the surface of the pavement.

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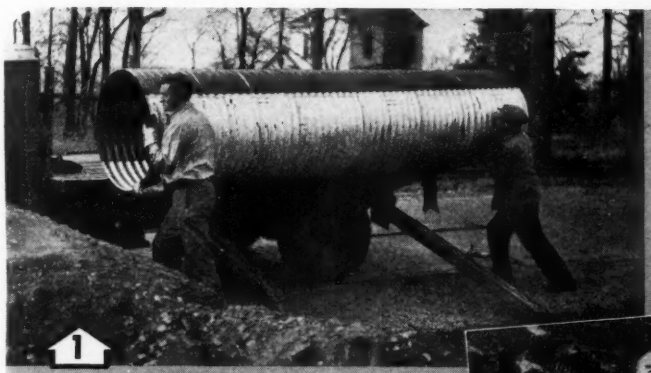

1

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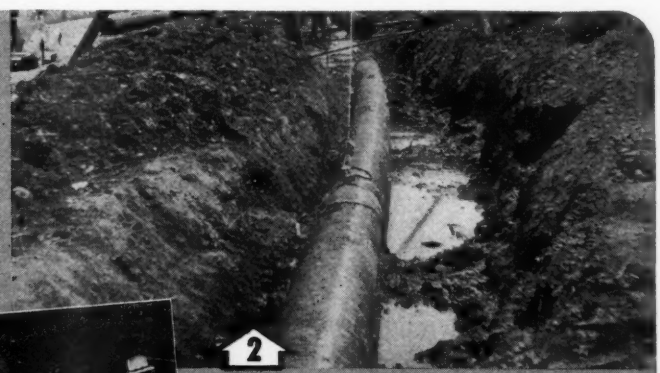

2

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3

4

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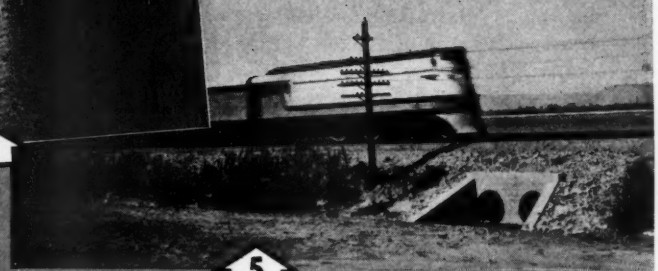

5

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ARMCO Paved Invert Pipe

When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 55-57

Four-lane concrete pavement between curbs. At the first joint below where the change is made from cut to fill, water is pouring out of the joint.

Lacking a more positive outlet, water coming down the grade under the pavement has saturated the shoulder.

operation of the drain may wash soil particles from under the edge of the pavement and lower the supporting strength. I have heard recently of a rather serious breakdown and undermining of pavement and runway edges adjoining drains. This may be due to using too large a particle size for the pervious backfill, or it may be due to a design which does not control the water inside the pipe, but permits considerable quantities of water to stand in the trench, or to move in the trench rather than in the pipe. Regardless of the reason, it should be guarded against. Other considerations which should influence the choice of location of the subdrain include:

(a) Full consideration should be given to the selection of a combined system, whose primary purpose is to convey surface water, under control, to a safe outlet, but whose secondary purpose is to lower and control the ground water. If this idea were adopted, the location of the proposed pipe line would obviously be under the gutter.

(b) If (a) design be chosen, it obviously calls for frequent surface water inlets and cleanout sumps for silt control.

(c) As discussed more fully under the subject heading "Perforations Up or Down," there is a strong trend toward placing the perforations up for normal use, as a subdrain. If this is done, there should be occasional manholes with sumps for inspection and cleanout purposes. These manholes should of course be placed at least a few feet away from the pavement edge.

(d) In heavy, water-retentive, high capillarity soils, there should be a continuous layer of pervious material under the pavement. With the usual type of construction, this pervious material is contained in a trench with impervious material confining it on each side. This in itself forms a hazard, for it invites the water in, but omits definite provison for getting the water out. So-called weeps (narrow outlet trenches through the shoulders filled with loose stone) are not enough; the subbase trench should be cambered to the side and definitely outletted. Where a subdrain is called for, the subbase trench may be positively drained into it, either continuously by extending the pervious material of the base course out to join the pervious material in the subdrain trench, or at intervals if the distance to the subdrain trench does not permit of continuous treatment.

Where no subdrain is available as an outlet for the subbase trench, other positive outlets should be provided, such as into manholes; culverts, trenches to the sides at frequent intervals, particularly where the grade line goes from cut to fill; and at low points in the grade.

One method of providing positive drainage for the subbase trench, at changes from cut to fill and at low points in grade, is as follows: Cut a deep, wide trench at least 2 ft. by 2 ft. in section below the bottom of the base course and from gutter to gutter. Place a piece of drain pipe in the bottom of the trench and convey to a positive outlet. If perforated pipe is used, see that the perforations are up or use unperforated pipe after it leaves the trench and becomes merely a carrier. Fill the trench with clean pervious material. Water intercepted by and flowing along the subbase trench is thus positively removed.

The location of the proposed subdrain may be under the gutter or a few feet from the edge of the pavement, depending on conditions. If the decision is made to put it under the gutter, it will have to be placed somewhat deeper for a given set of conditions in order to lower the ground water curve under the pavement to a safe elevation.

The question then arises, on which side of the pavement should the subdrain be placed? In the Northeastern States a major fraction of highway mileage involves side hill work. In those cases where the soil strata cut directly across the highway location, or on a slight diagonal, there will usually be no question but that the proposed subdrain should be on the high side —the direction from which the underground water comes.

But, as the direction of flow across the highway location becomes a long diagonal and particularly when it roughly parallels the highway direction or when the highway is in a cut, then doubt arises as to what to do. Starting with a subdrain on one side, for the normal case, as conditions get worse we are forced to a subdrain on one side, plus bleeders diagonally under the pavement.

When we come to locations where the direction of underground flow parallels the highway, particularly when this combines with extensive back slopes, long through cuts and heavy soils, it may be necessary to use two subdrains. The width of the highway enters into this also. Wide highways, particularly the divided type, involve a large investment and therefore justify the expenditure of a larger amount to protect the original investment.

In situations such as these, frequent inspection holes and the determination of soil profiles and water bearing strata prove particularly valuable.

Depth of Subdrain

Over a period of time several of the Northeastern States had adopted a standard depth for subdrains of 3 ft. 6 ins. from shoulder or gutter line to the flow line of the subdrain pipe. This depth possibly was chosen because 3 ft. to 3 ft. 6 ins. is the normal depth of frost penetration for much of this area. It was thought that a subdrain below frost line should continue to function through the winter and also would keep the water table down to that elevation and therefore prevent frost heaves and frost breaks.

There was considerable evidence that subdrains at this depth were not functioning properly; but it was difficult to decide what the principal cause of failure

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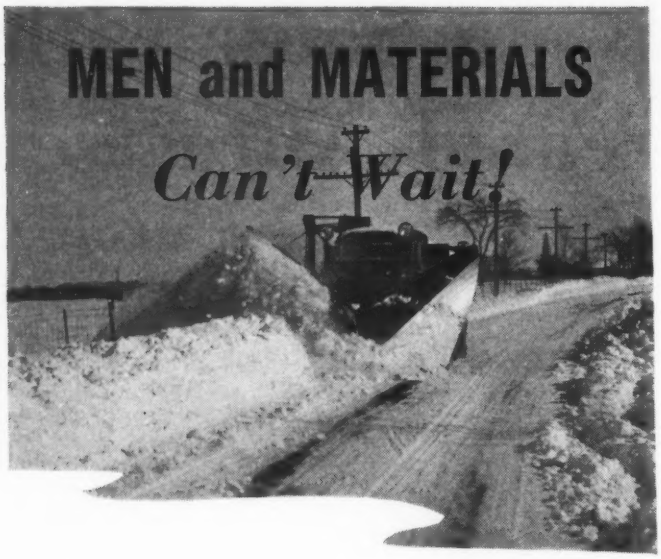

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might be, partly because these cases of subdrain failure were scattered so that no one man or small group of men were having numbers of such failures brought to their attention.

In 1939 one of the New England States was faced with a major reconstruction and rehabilitation program covering a large mileage of old highways. Maintenance costs were advancing year by year and the situation seemed to be getting out of hand. As a primary step, the work of the maintenance division was definitely separated into two parts. Under the maintenance engineer, one principal assistant had charge of drainage maintenance and the other of surface maintenance. Before any new surfacing could be placed on a proposed reconstruction program, the drainage engineer had to make a careful checkup and correct drainage deficiencies.

A large percentage of the drainage deficiencies consisted of a lack of proper subdrainage, as evidenced by serious surface damage from frost heaves and frost breaks, and by a great deal of ice formation on the pavement during winter and early spring.

Left—6" drain at a depth of 3' 6" in heavy clay failed to protect the pavement and is being replaced by a 15" perforated pipe with perforations on top. Right—drain (broken open for inspection) not over 4 years old, on 6" of broken stone. Water is flowing through the stone below the pipe, but none in the pipe.

Fortunately, this drainage engineer had a fine background of highway and drainage experience. During the latter part of 1939 he tried out his ideas of subdrainage procedure on a number of test installations. The places chosen were those where maintenance costs had been very high every winter. Ice formation on the pavement made it necessary for maintenance crews to chop ice day after day and week after week during freezing weather. These installations of subdrainage proved so successful through the winter of 1939-40 that in the spring of 1940 the drainage engineer was authorized to go ahead with a major program of drainage correction. One of the primary decisions made was that in all cases he should dig inspection holes and identify the soil conditions and water bearing strata before deciding on the depth of the subdrain. All of the old failed drains were found to be at a depth of 3 ft. 6 in. Fuller data on the findings from test holes are given later.

Word got around of the good work that was being done on this drainage program and a neighboring state, which was about to initiate an investigation of its own, was encouraged to go ahead. This second high-

way department confined its efforts to those places where there were known to be subdrains installed which, from the evidence of the pavement and the shoulders, were not functioning properly. A considerable number of locations were studied, inspection holes being dug down to the drain large enough to get a clear idea of conditions. In this state also the standard depth of flow line of drain was 3 ft. 6 ins. Lack of depth appeared to be one, but by no means the only, cause of the failure of the drains to function.

If 3 ft. 6 ins. is not an adequate depth for subdrains in the Northeastern States, what then is an adequate depth? The answer is not in a book; it is out in the field. Inspection holes must be dug, not only to find the water bearing strata but in order to identify the soil types. Also, there must be some knowledge of the soil types that occur and of their influence on drainage.

Facts About Subsoil Water

It is known that the horizon of a water table, when acted on by a drain, is drawn down like a broad V, with the sides curving, the drain being at the point of the V. In the case of a very pervious material, the slopes of the sides of the V are very flat. In the case of a relatively impervious material, the slopes are steeper, and this slope is generally on the order of the head necessary to make gravitational water flow in the given material.

Under a highway pavement or an airport runway, there must be a certain minimum thickness of unsaturated soil in order that there shall be enough crustal strength properly to distribute the loadings over safe areas. Let us assume any one of several high-capillarity types of soil, and a subdrain at a depth of 42 inches. Because of the nature of the soil, the ground water curve will rise rapidly until, under the pavement, it is dangerously high. In other words, in a so-called heavy or high capillarity type of soil, a 42-inch depth will not be enough to insure the ability of the subgrade to furnish adequate support for the pavement

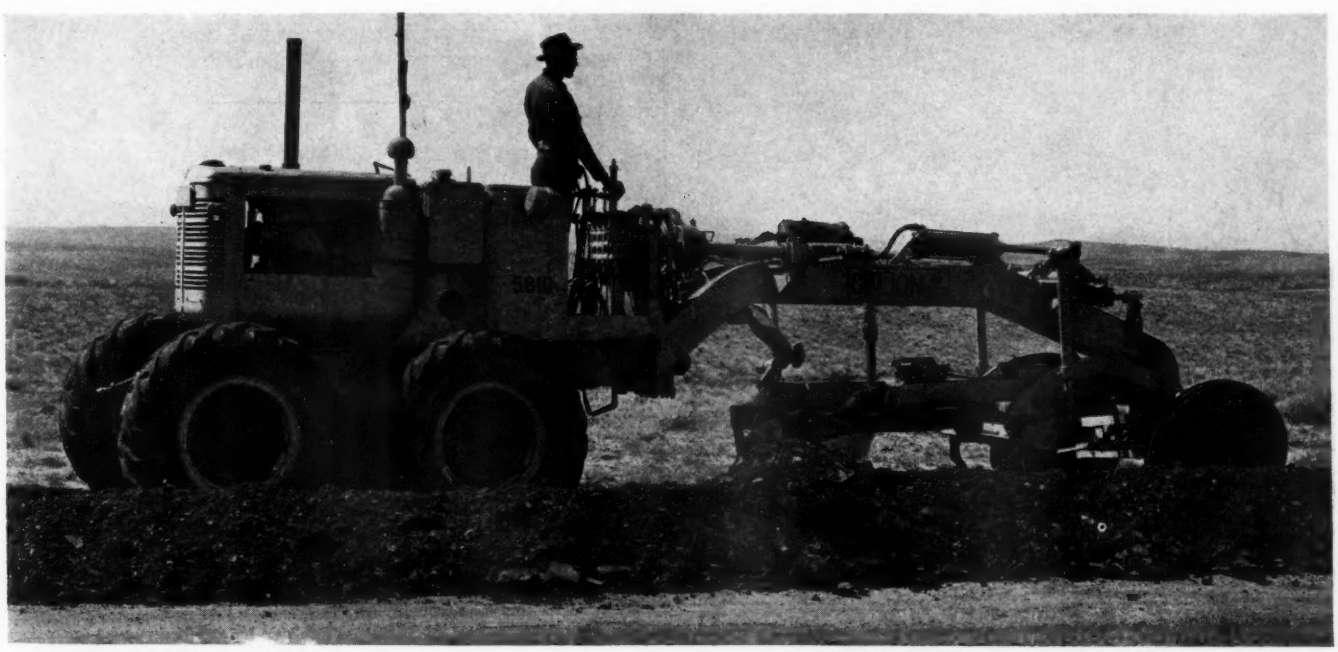
There are a number of other factors, however, including the influence of mixed soil types and of freezing and thawing, the formation of ice lenses, the presence of considerable volumes of free water under tight pavements, etc.

I am not trying to make this subject appear extremely difficult but I am prepared to say that it is complex. However, when a subdrainage program of scores of installations is put through in one year, as was done in one state, and only three of them turn out less than satisfactory, I should say that excellent progress is being made. Further than that, this engineer's method of dig and identify has apparently already shown what was wrong with the three mentioned.

Because of the known difficulty of draining certain soils, it has been said that a subdrain is of no value in such soils. This is doubtful. A well designed and well constructed subdrain, taking out most of the water, plus a blanket of a moderate thickness of very pervious material under the pavement, plus drainage of this pervious blanket, should take care of most situations.

To sum up: the depth of subdrain essential to do a certain job will be a function of distance of subdrain from pavement; soil types; soil uniformity, or lack of it; depth to water bearing strata or to water table; and severeness of winter weather.

(To be continued)



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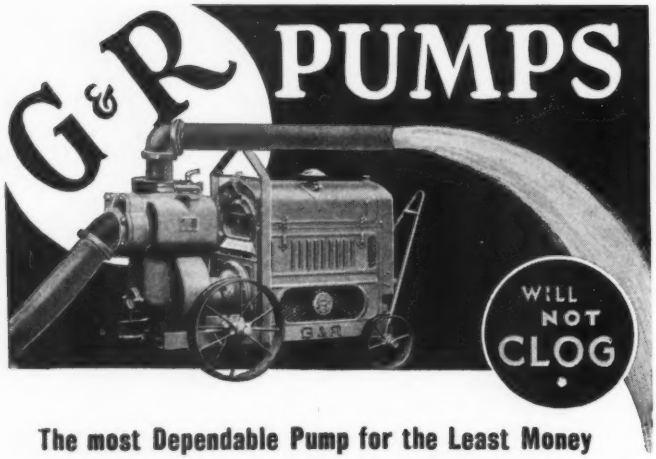

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Creosoted Black Gum Bridge Floors

Highway departments frequently place creosoted black gum as a floor or wearing surface on old steel bridges. The usual method followed in building a wood floor system for such structures is to place a creosoted subfloor of Douglas fir or southern yellow pine plank transversely on the stringers, and bolt to it a wearing surface of creosoted black gum plank, laid longitudinally. Dressed plank of 3-in. nominal thickness is generally required to secure a smooth, even surface suitable for fast motor traffic.

The Kansas State Highway Department has installed a number of such decks, and their specification requires that the black gum shall be common dimension plank, free from wane, and pressure treated with a final retention of 10 lbs. of creosote per cubic foot. The plank are fastened to the subfloor by carriage bolts at the ends and along the sides. Experience has shown that the best results are obtained from black gum wearing surfaces if the heart faces are turned down and only the sapwood face exposed to traffic. Exposed heart centers sometimes have a tendency to shell out under traffic, but the sap faces remain smooth and are highly resistant to abrasion.

One of the early floors of this type on the Kansas State Highway system was placed in 1933 on the bridge over the Marias des Cygnes River on Highway 69 at Trading Post. This bridge is about 225 ft. long, and traffic ordinarily ranges from 1,200 to 1,500 vehicles daily. The subfloor is 3 x 12-in. x 16-ft. pine, and the gum plank surfacing is of the same size, all treated with 10 lbs. of creosote per cubic foot. Curbs are creosoted pine. This floor is free from decay and in excellent condition. The only noticeable wear that occurred was in a few plank which were laid with the heart side up. In these the centers had shelled out a half inch or so, but were evened up with asphalt by the maintenance forces.—"Wood Preserving News."

Improvements for Everett Water Supply

(Continued from page 20)

Plans also call for the construction of a 20,000,000 gallon reservoir at Everett. This will require the moving of some 440,000 cubic yards of material in excavating and grading, over 20,000 cubic yards of trench excavation for pipe line changes and over-flows, the placing of 30,000 cubic yards of reinforced concrete and the laying of 4,200 linear feet of 4-in. and 6-in. concrete pipe; installation of a new valve house and equipment; pipe line changes and the laying of 1,500 linear feet of 4-in. over-flow pipe line.

The construction of 20 miles of 20-ft. gravel roads was necessary for hauling in the heavy equipment used in building the dams and reservoir and the equipment and material for building and laying the pipe lines. This required clearing and grubbing of 50 acres, 180,000 cubic yards of grading and excavation, 1,002 linear feet of 12-in. concrete culverts; 105,600 linear feet of sloping and ditching and 10,000 cubic yards of gravel surfacing.

These roads will be maintained after the completion of the water system improvements, for purposes of inspection and maintenance and to allow the people from surrounding communities to use the beautiful country of the watershed for recreational purposes. Additional plans to improve this area for recreational purposes call for the construction of several miles of trails, camp tables and other park facilities.

Sewage Sludge Digestion at Marion, Indiana

(Continued from page 14)

all of the air for the aeration of the activated sludge process, and heat the office and the laboratory building throughout the winter months. Practically all the heat required for maintaining digestion temperatures and for heating the office and laboratory building was ob-

TABLE NO. 2

Total Solids and Volatile Loading of Digesters

Date	Total sol. added in dry pounds	Pounds of volatile solids added	Lb. of solids added per mo. per cu. ft. of digester	Lbs. of vol. added per. mo. per cu. ft. of digester	Percent of vol. in raw sludge	Percentage reduction in volatile
July 1940	110,900	82,000	0.660	0.492	73.8	
August	146,759	110,196	0.877	0.658	73.9	65.5
September	197,640	148,640	1.185	0.890	73.8	66.3
October	328,080	206,530	1.960	1.238	71.5	63.7
November	274,200	174,160	1.640	1.042	69.7	60.0
December	298,223	202,330	1.785	1.211	72.6	65.2
Jan. 1941	293,738	172,540	1.755	1.033	66.9*	69.7
February	206,000	128,000	1.235	0.767	63.4	62.3
March	247,800	157,710	1.479	0.943	64.9	60.8
Average	233,700	153,569	1.397	0.919		64.2

*The decrease in percentage of volatile matter in the raw sludge for Jan., Feb., and March, 1941, is due to a change in laboratory analysis of the sludge rather than in the composition of the sludge.

TABLE NO. 3

General Plant Data

Date	Sewage flow, million gal.	Total gas produced in cubic feet	Cubic feet of sewage gas used	Value of gas used at plant	B.O.D. of raw sewage in p.p.m.	Percent of B.O.D. removed
July 1940	57.6					
August	65.0	1,097,580	999,525	$499.76		
September	67.5	1,851,964	1,733,114	866.55	248	92.3
October	59.0	1,697,295	1,611,570	805.78	232	94.3
November	59.0	1,425,330	1,348,490	674.24	204	85.8
December	66.2	1,635,197	1,463,715	731.85	273	92.0
January 1941	65.7	1,574,360	1,416,330	703.16	278	94.8
February	68.1	1,555,440	1,373,160	686.58	266	95.8
March	70.2	1,776,130	1,520,000	760.00	332	95.8
Average	66.4	1,576,662	1,435,653	$715.99	262	93.0

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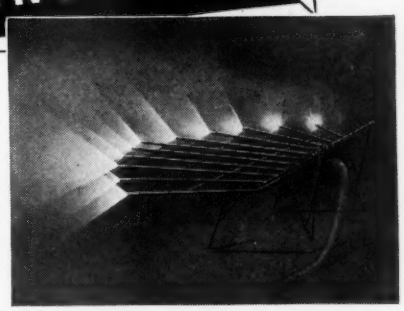

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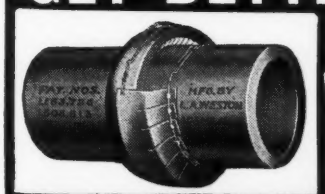

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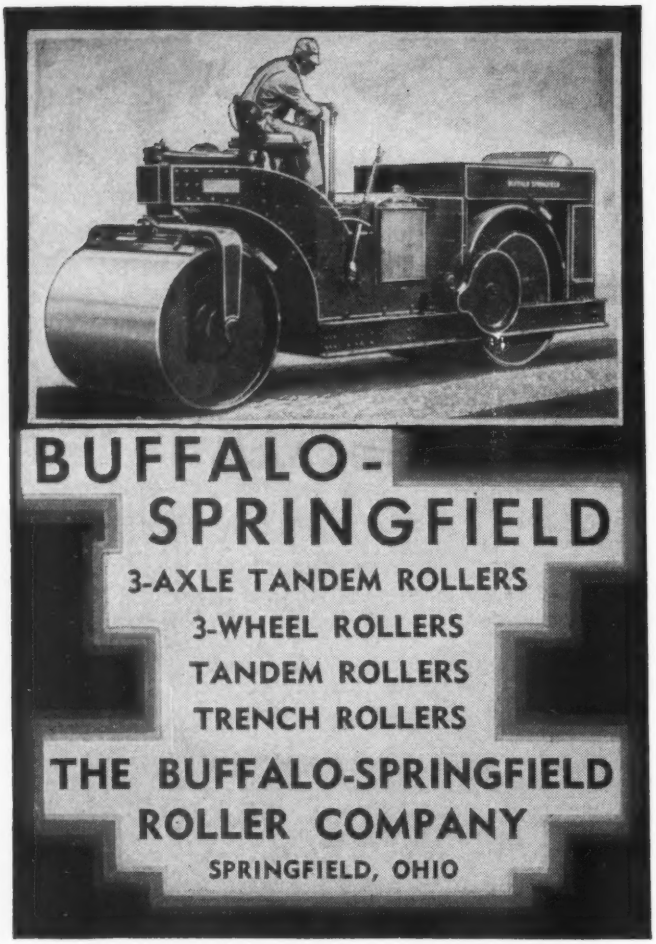

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tained as waste heat from the engine jacket and the exhaust cooling water.

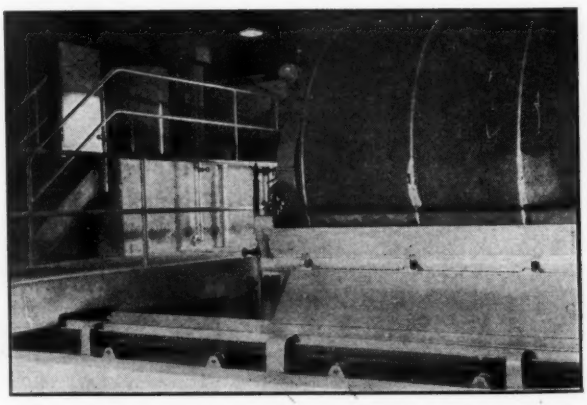
The supernatant liquor drawn from the secondary digestor remained in good condition during the first four months of operation. At this time an excess of digested sludge being carried in the secondary tank caused the supernatant to become heavy with digested solids. For several days the total solids content of the supernatant returned to the primary settlers was as high as 2.5%. This condition was relieved by the removal of the digested sludge from the bottom of the tank. It has been possible on several occasions to thicken the digested sludge to 7.0% total solids before removing same on the vacuum filter. This procedure effects quite some economy in the operation of the filter. It is interesting to note that 780,000 pounds of solids had been added to the digestion system during the first 120 days, while only 11,900 pounds of digested solids were removed.

In Table No. 1 a summary of solids loadings and corresponding gas productions during successive eight day periods is shown. All volatile solids recirculated as supernatant are deducted from these figures. The cubic feet of gas per capita ratios are based on the 1940 census of 27,600 population. The weight of the mass of gas removed is calculated from the estimated value of 6.5 pounds per 100 cubic feet of gas having a composition of 31% carbon dioxide and 69% methane. In the last column the percentage ratio of the weight of volatile material removed as gas to the total volatile weight added as primary sludge for the same period of time is given.

Spent lime-sludge from the city water works plant was taken into the sewage plant at the rate of one ton per day during 13 days of October, 7 days of November, and 11 days of December. Packing-house waste during the five months from November to March averaged 2,500 hog units per month.

In Table No. 2 the solids and volatile loadings are compared by months and the relations of the monthly loadings to the digestion system capacity in cubic feet is given in the third and fourth column of the table.

The information given in Table No. 3 is presented to show the volume and strength of the raw sewage treated, together with the degree of purification obtained. The value of the sewage gas used is based on the cost of an equivalent amount of utility gas which would be required to replace it. Biochemical oxygen demand tests were not made during the months of July and August and therefore are not listed.

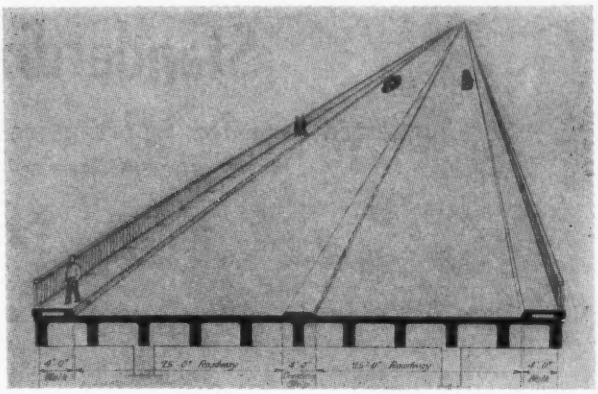


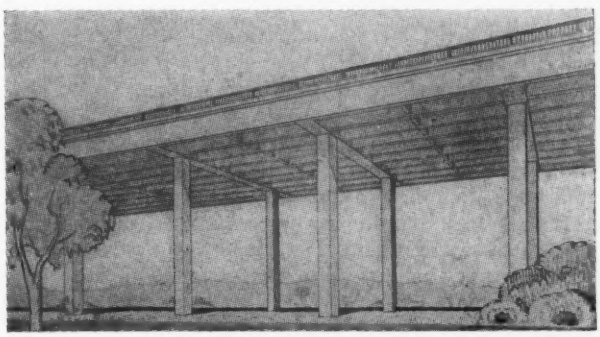
Equipment for chemical conditioning and de-watering sewage sludge for fertilizer

Four-Lane Viaduct Replaces a Flooded Highway

PLANS are being prepared for a new four-lane viaduct across the American river on U. S. 40 between Sacramento and North Sacramento, Calif., to carry traffic which at present amounts to 20,000 to 25,000 cars daily. The viaduct will be 1,496 ft. long, consisting of 36 spans of 41 ft. with a 10 ft. cantilever span at each end. It will have two 25 ft. roadways with a 4 ft. dividing strip between, plus two 4 ft. sidewalks. It will be a continuous reinforced concrete structure supported on two-post reinforced concrete bents on pile foundations, since the soft silt and clay soil found near the surface is not suited to spread footings. There will be a total of five expansion joints in the length of the structure. At the point of maximum height the viaduct will be slightly more than 50 ft. above the ground.

This viaduct will replace a road which is flooded whenever the American and Sacramento rivers reach an elevation which they have surpassed during six of the past twelve seasons, necessitating a detour which adds 30 to 60 minutes to the time between the two cities. To raise the road on embankment or protect it by levees would so reduce the flood channel of the river as to raise the flood elevation still higher and cause it to overflow levees and lands up stream from this flooded road. The viaduct therefore seemed to be the only solution, although an expensive one. It will be located about 300 ft. from the present road, which therefore can continue in use until the viaduct has been completed.





Sketch of proposed viaduct that will carry a 4-lane divided highway section of U. S. 40 across American River overflow.

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Deriving Gas Engine Operating Costs and Standardizing Reports

Suggested plan for reporting costs that will show whether the gas engines are a paying investment.

By R. W. FRAZIER
Superintendent, Oshkosh, Wisconsin

IN deriving costs of operation of a gas engine in sewage plant operation, various methods have been used in arriving at these costs. Variables in plant installations are such that individual consideration has to be given to each case. The cost per KWH and net savings on the operation of the gas engine is the ultimate end of the accounting. The question is, how to derive the figures, and what is to be considered in the cost accounting.

A number of gas engine installations have been made with the assistance of Federal funds, these installations including appurtenances for the operation of the engine. Some cities have charged off the percentage donated by the agencies; but figures so derived are not comparable with those for installations for which no such aid or a different percentage of aid was received, and are of little value.

A question arises, whether or not appurtenances such as gas-holders, meters, gas compressors, electrical equipment and buildings should be charged against the engine. Some of the plants have a number of these appurtenances so charged, while others do not.

In the treatment of sewage where sludge is digested and gas generated, some disposal of the gas has to be made. One instance I know of, where gas meters and holders are installed, in which the gas is used only for heating, and since all of the gas is not needed for heating, the excess is burned in the atmosphere. No doubt, a number of the appurtenances are necessary adjuncts to the collection and distribution of the gas, but may not affect the operation of the engine as far as operating costs are concerned.

A number of communities have their own electric plants and if power is used, the cost of power may be smaller. Others have to purchase power on an industrial basis, either on a flat rate per KWH or on a graduated scale. Others generate power and sell their excess power to the electric utility, possibly at the same rate as they purchase their deficiency. All in all, this varies in each community.

In suggesting a standard plan to follow for reporting gas engine operating costs, consideration should be given to the kind of a report which will appear favorable to the governing body or community. This report should show the essentials that are of interest to all.

The following is a tentative outline that may be followed in making the report:

1. Make of engine and year installed.
2. Size; HP; No.
3. Use: generator, pumps, blower.
4. Cost (actual)—disregarding Federal funds.
5. Maintenance cost.
6. Repairs (gaskets, rings, plugs, etc.).
7. Supplies (grease, oil, etc.).
8. Depreciation (actual cost).
9. Interest on investment.
10. Insurance.
11. Labor (overhaul, repairing).
12. Compensation on labor.
13. Total cost of operation.
14. Hours operated.
15. KWH (generated; m.g.d. pumpage; or cu. ft. air produced).
16. Cost of power purchased per KWH.
17. Total power purchased.
18. Total power generated.
19. Cost of power generated at utility rate.
20. Net savings shown for power generated over the amount if power had to be purchased.

In all cases, the cost of gas engine operation is to bring out whether or not the engines are a paying investment.

The above is condensed from a paper presented before the Fifth Annual Meeting of the Wisconsin Sewerage Works Conference.

GAS ENGINE OPERATION—(Le Roi)

Sewage Treatment Plant, Oshkosh, Wis.
October 5, 1937, to Feb. 12, 1941

	No. 1 Engine	*No. 2 Engine*
Labor—Supervision for maintenance and repair	$ 1,015.70	$ 301.60
Compensation Ins. on Labor	17.06	4.07
Repairs—oil—grease—supplies	687.25	295.54
Depreciation	655.01	655.01
Interest on Investment	357.26	357.26
Insurance	67.46	67.46
Total Operating Cost	$2,799.74	$ 1,680.94
No. 1 Engine operated 18,004 hours, generating		562,928 KWH
No. 2 Engine operated 7,694 hours, generating		226,692 KWH
Total Power Generated		789,620 KWH
Average KW per hr.—No. 1 Engine	31.2 @ cost of	$ .00497/KWH
Average KW per hr.—No. 2 Engine	29.4 @ cost of	$ .00741/KWH
Average total cost of power generated	4,480.68 / 789,620 =	$ .00567/KWH

Total Power Cost at Plant.

Power purchased	$ 5,676.85
Penalty—min. charge	292.52
Operating cost	4,480.68
Total Power Cost	$10,450.05
KWH Purchased	279,312
KWH Generated	789,620

Total generated and purchased 1,068,932 KWH
Total cost of power generated and purchased, per KWH = $.00977

Power generated @ P. S. Corp. rates—		
No. 1 Eng.	562,928 x .02	$11,258.56
No. 2 Eng.	226,692 x .02	4,533.84
Value of power generated @ P. S. Corp. rate of .02 per KWH		$15,792.40
Operating Cost		4,480.68
Net Savings on Power Generated—3 1/3 years		$11,311.72

Rapid Method for Mechanical Analysis of Soils

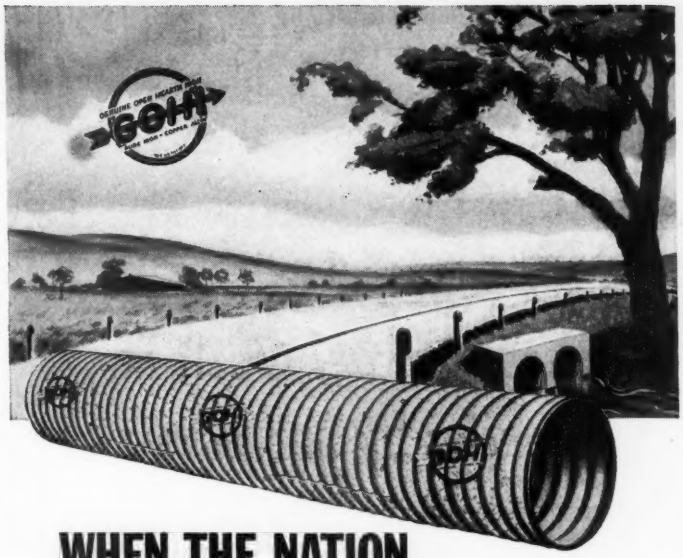
In the stabilization of large areas it is often necessary to determine quickly on the site the composition and particle size distribution of the soil types encountered. The usual sedimentation methods of analysis are too slow for this purpose, and neither the sensitive laboratory apparatus nor the necessary staff are readily available. A simple method, based on the standard method but also taking into account the phenomena due to vortex formation, has therefore been devised by the German Research Association for Soil Mechanics. A brass or aluminum cylinder of 37 c.c. (2.26 cu. in.) capacity is completely filled with the moist soil which is then placed in a dish with a little water, and the particles are carefully separated. Five c.c. of water-glass is mixed in to prevent subsequent coagulation of the suspension in the sedimentation vessel. The whole is then transferred to a flask, the flask is filled with water, and a measuring cylinder is placed over the neck of the flask. The neck of the flask and the upper part of the cylinder are of ground glass to ensure a tight joint. The apparatus is agitated by hand for 1 or 2 min., and the suspension then allowed to settle into the cylinder. The volume of sediment in the cylinder is read after various time intervals between 5 sec. and 5 min. and the results noted. The approximate mechanical analysis can then be derived in simple fashion from charts. It was observed in the experiments that all particles down to the 0.02 mm. size settled in 5 min. Comparative curves illustrate the results obtained from this method and from the aerometer method of A. Casagrande. The rapid method is not intended to replace the normal sedimentation analysis, but to serve as a practical determination of the particle size combination on the site, for which it is sufficiently accurate.—*Highway Research Abstracts.*

Construction of Charleston's Edisto-Goose Creek Tunnel

(Continued from page 16)

was sheathed down to the marl; but where it was deeper, the caisson method of shaft sinking was adopted. After a cassion had entered the marl a short distance, the marl was undercut about 18" for a depth of 3 to 5 ft., and this undercut section filled with concrete up to the bottom of the concrete caisson; this to make a tight seal against the ground water which was found in the sand and phosphate rock just above the marl. Elevators in the shafts raised the muck cars to the surface. Mercury plumbs supported by piano wire, about 9 ft. apart in each shaft, were used for giving tunnel alignment.

From each shaft the tunnel was carried in both directions, with an up grade of about 0.2% to afford drainage to the shaft sumps and make it easier to push the filled muck cars to the shaft. The muck cars were 18½ and 24 cu. ft. capacity, equipped with Timken or Hyatt roller bearings. At each shaft were installed an air compressor of 160 cu. ft. capacity, a 5 kw DC lighting plant, and a Ford V-8 industrial gasoline engine direct-connected to a United Hoisting Co., double reduction single-drum hoist. Seven of the compressors were Gardner-Denver diesel driven, 6 were Ingersoll-Rand Type H engine driven, and 4 were Ingersoll-Rand Type CHK gasoline driven. The



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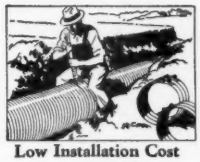
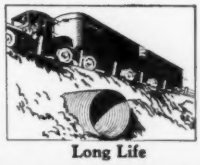
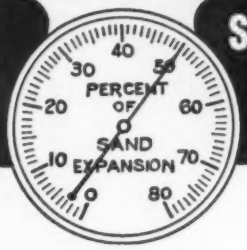

Low Installation Cost

Minimum Backfill

No Repairs, No Upkeep


Long Life

GOHI CULVERT MANUFACTURERS, INC., NEWPORT, KY.



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—Eliminating Mud Balls and Filter Cracks

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The use of sand expansion as a means for wash water control has long been accepted, but until the development of the Simplex sand expansion indicator, no device was available by means of which this expansion could be definitely measured, noted, and checked at any period during the wash cycle.

Over 300 units installed and operating in such recognized plants as those in Allentown, Raleigh, Greensboro, Sandusky and Toledo, have proved that by their use greater operating efficiencies have resulted because of increased filter runs, reduced costs, and elimination of troubles from mud balls and sand cracks.

The sand expansion indicator, low in price and simple in mechanical construction, fills the requirement.

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Also manufacturers of SIMPLEX AIR DIFFERENTIAL METERS for Water and Sewage Treatment Plants, and SIMPLEX GYROMETERS for Venturi Tubes, Nozzles, Orifices, or Pitot Tubes.

Bulletins 101 and 120, respectively.

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6750 Upland St. Philadelphia, Pa.

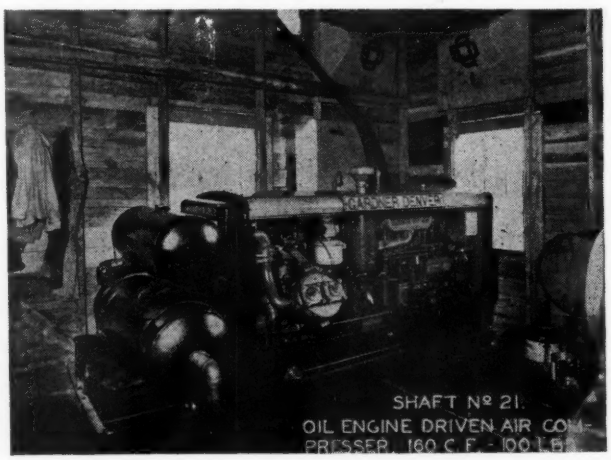
oil engine compressors have many advantages over the gasoline, particularly in the territory through which this tunnel was constructed, in that the quantity of fuel required is reduced to about ¼ and the loss by waste and theft is immaterial. At the foot of each shaft was a small Duplex pump using compressed air as the motive power, for pumping to the surface the seepage water and condensation from the compressed air. These pumps were used only a few hours a day—not more than 12 hours when draining the entire 6,000 ft. of tunnel.

In driving the heading, five holes 5 ft. deep were shot with 60% gelatin powder, lightly tamped, which shattered the marl. Each 10-hour shift made two or three explosions, cleaned up the muck and trimmed the tunnel roughly to shape, leaving about 2″ to be dressed out by the finishing crew after all the headings had been holed through. Finishing of the surface was done by hand using pneumatic spades and, for the final trimming, an ordinary carpenter adz with about 4½″ blade with the curvature slightly increased so that, starting at the top, a man could trim downward on each side, using a light wooden templet to get the true form and shape.

No ventilation was provided, the 5″ well openings and discharge from the air drills and spades affording all the ventilation required. The temperature remained at a practically constant, comfortable point both winter and summer.

Most of the work was done by task, each shift being allotted 51 ft. of tunnel heading a week for a fixed sum, with an additional amount per foot paid for all over this. The 51 ft. was exceeded nearly every week, reaching 92.4 ft. one week.

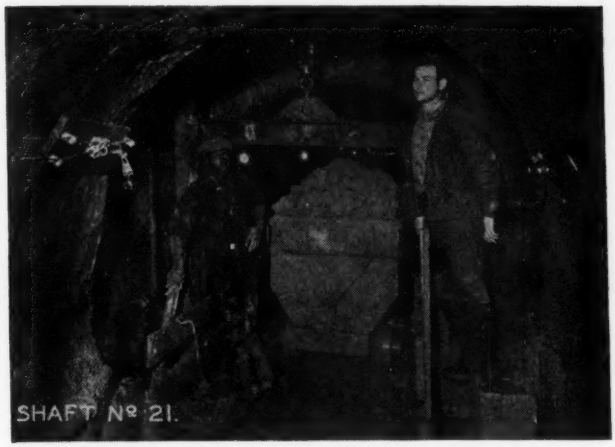
Two shafts, located about five miles apart on the bank of Ashley river, are provided with gates, and by



Oil engine-driven air compressor, 160 c.f.—100 lb.

closing these the water can be diverted from the upper shaft into the river, flow down the river channel and re-enter the tunnel at the lower shaft, making it possible to unwater this section of tunnel. By a similar means the next two miles can be cut off. Also, all shafts are provided with grooved slots so that stop logs can be inserted and any section of the tunnel be unwatered and inspected.

Stevens automatic recording gauges and charts are installed at the intake and four other shafts to record the water level at these points, affording data



Foot of Shaft No. 21. Note sharpness of intersection of shaft and tunnel walls after 6 months use of lift

which permit a very close calculation of the amount of water passing through the tunnel, and give immediate notice of any obstruction occurring in the tunnel.

The above comprises considerably condensed excerpts from a paper before the New England Water Works Ass'n by J. E. Gibson, Manager and Engineer of the Charleston Water Department.

Control of Water Pipe Line Laid in Highway

Action was brought by a motorcyclist against a water company for injuries sustained when plaintiff's motorcycle hit a hole or depression in the road from four to eighteen inches deep, on the ground that the highway was caused to sink by water escaping from a broken pipe of the water company. The California Supreme Court (Juchert v. California Water Service Co., 106 P. 2d 886) held that the doctrine of res ipsa loquitur applied, since the water company owned and operated the pipe and was under a duty to maintain and control it. The water company contended that its control was not exclusive, since the pipes were laid in a public highway which was at all times under the control of the state. The court, however, said that there was no showing that the state highway department ever exercised any control over the pipe other than in a supervisory capacity during its installation. "The mere fact that permission would have to be requested from the highway department to open the gravel strip in which the pipe was laid would not take the pipe from plaintiff's exclusive control, especially where it was not shown that such permission was more than a mere formality or would ever be denied." In the absence of other explanations, a new cast iron pipe, laid for about five or six months, for the purpose of carrying water, should not have burst, the court said, if those in charge of its installation and maintenance had been free from negligence.

Frogs Clog Sewage Distributor

Chatham, N. Y., operates a sludge digestion-trickling filter type of sewage treatment plant, and finds little difficulty in operation except in clogging of the distributor nozzles. Part of this is caused by water-soaked matches which, being below the surface, are not removed with the grease and scum. Another cause is frogs that get into the settling and dosing tanks and are siphoned to the distributor nozzles. As many as twenty frogs have been taken from the distributor at one time.

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The combination of concrete and steel used in Lock Joint Pressure Pipe is one that can really take it! The steel reinforcement is designed at a conservative stress to effectively resist all internal pressure and provide a high factor of safety against sudden surges or other overloads.

Of equal importance, the initial strength of Lock Joint Reinforced Concrete Pressure Pipe cannot be diminished by corrosion. The reinforcing steel is embedded in and protected by the rich, dense concrete which permanently preserves the full cross-section and strength of the steel.

Proof of strength? Although many installations are twenty, thirty years old, Lock Joint Reinforced Concrete Pressure Pipe has never burst or collapsed.

If your projected work includes pressure pipe lines for water supply, sewers, subaqueous intakes or outfalls, remember Lock Joint Pipe—the pipe that needs no pampering.

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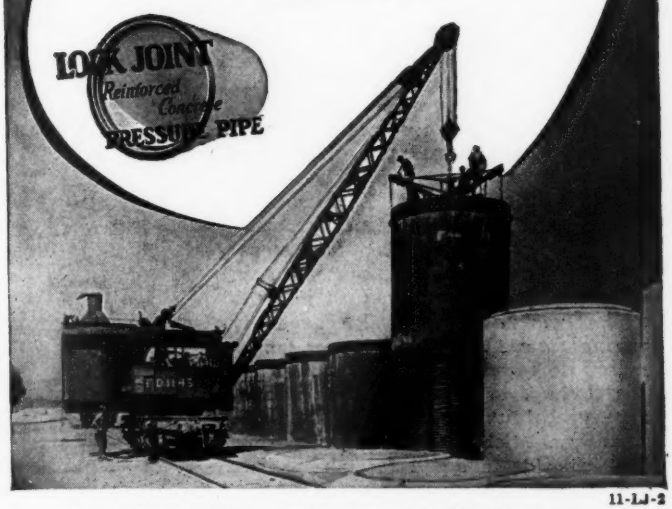

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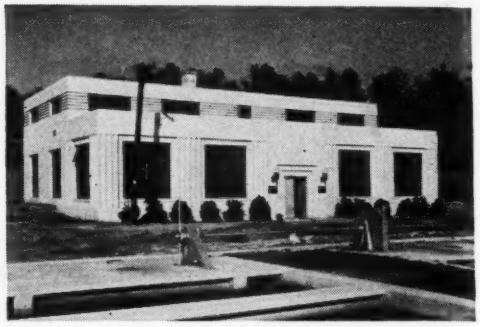
The Sewerage Digest

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published.



HOW TO FIND ORIGINAL ARTICLES. Key letter at end of each digest refers to name of publication listed in bibliography at end of this section. Numeral indicates title of article.

Alum Treatment Of Digested Sludge

That alum materially hastens the dewatering and drying of some sludges was demonstrated by John R. Downes in 1923 (see PUBLIC WORKS, July, 1923) and it has been recently rediscovered. In 1939 the Aurora, Ill., Sanitary District tried out the use of it quite thoroughly, and from their experiments and experiences drew the following conclusions: Alum appears to be the most effective and economical agent for dewatering sludge. Di-valent (ous) iron salts produce no dewatering effects; and while such effects are produced by trivalent (ic) iron salts, these tend to deliver ferrous iron to the underdrains and clog the sand with iron oxides. Sulfuric acid is reported as effective as alum at some plants; as also is activated carbon, but this proved ineffective on Aurora sludge.

Alum is most effective on sludge with a total solids content under 9%. On sludges under 3%, 1 lb. to 200 or 300 gal. is as effective as three times that amount. The maximum effect occurs in the first 24 hrs. Alum-treated sludges are much less affected by rain after the discharge than sludges not so treated. The sand in the sludge drying bed should be definitely coarse and the drain tile ample. Greenhouse experiments with the sludge as fertilizer indicated that there was no adverse effect on plant life where alum had been used. Alum may not be equally effective as a dewatering agent on the sludge from all plants; each should try it out before adopting it. It is especially valuable as insurance against unexpected weather conditions when applied in spring, fall or winter drawings. It saved its cost at Aurora when applied to winter-drawn sludges.[C 64]

Vacuum Filtration of Sludge

As compared to sludge drying beds, vacuum filters occupy much less space, are not affected by weather, permit cutting down or even eliminating digestion, and create no nuisance; but are relatively complicated mechanically and require conditioning under technical control. Preparing sludge for treatment consists of three steps: Digestion (not essential), concentration, and chemical conditioning. Cost includes labor (nominal); chemicals, generally ranging from $1.50 to $5.00 per ton of dry solids; power, about 25 kwh per ton; filter cloths, 3 to 5 cents per ton; maintenance, probably not over 2½% annually.

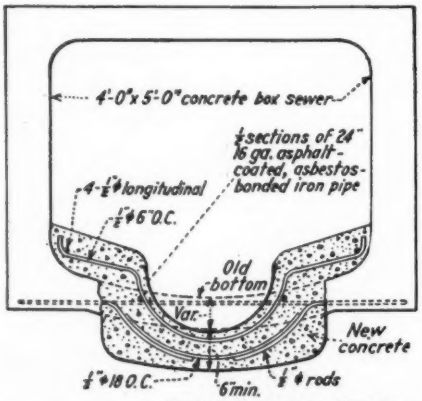
Lansing, Mich. finds that purchasing ferric chloride in liquid form has eliminated troubles experienced with feeding ferric chloride purchased in crystal form and cost them $2,500 less a year. Both Lansing and Muskegon found lime clogging of pumps and piping as well as filter cloths a problem; the worst being the ¾ in. filter piping inside the drums which had to be removed and bored out. [C 65, 66, 67]

Cleveland's Easterly Plant

During the first full year's operation of Cleveland's 123 mgd Easterly activated sludge plant it treated an average of 80.6 mgd of sewage, removed 96.4% of suspended solids, 93.5% of B.O.D., 99.3% of bacteria (99.9 when chlorine was used), and 84.1% of the organic nitrogen. Air applied averaged 1.16 cu. ft. per gal. of sewage. The sludge was pumped 13 mi. to the Southerly plant where it was digested in 12 tanks, where 315 mg of sludge produced 268 million cu. ft. of gas, of which 46% was utilized. Sludge cake was incinerated, using 6.1 gal. of fuel oil per ton. Passing grease skimmings through a pipe line gave trouble by accumulating therein in cold weather; were loosened by high-pressure water or steam from the boiler plant.[E 16]

Making Sanitary Sewer Out of Combined

Sheboyban, Wis., in making a combined sewer system into a separate one, found that in one district it was cheaper to build new storm sewers and use the existing trunk line as a sanitary sewer than to continue to use the storm sewer as such and build a new sanitary sewer. The storm sewer was 4 x 5 ft. box sewer, and the bottom was reformed as shown in the illustration. Part of the concrete bottom, including the reinforcement, was cut out and the ground below excavated, new reinforcing steel, bowed down, was spliced to the old and a second set of reinforcement added. Then concrete was placed to a point slightly above the line of the new bottom and half-sections of asbestos-bonded, fully coated, paved-invert pipe was firmly imbedded in the concrete to grade and held there by 2 x 4 in. spreaders spiked to 6 x 6. in braces wedged between the side walls. Then the rest of the concrete was placed. The half-pipe was in 4 ft. lengths and the overlapping reinforcing angles of adjoining sections were bolted together. Total cost of the 960 ft. was $11,665, of which material cost $4,235[E 17]



Courtesy Engineering News-Record

Conversion of a box culvert to sanitary sewer service with the aid of half sections of iron pipe.

Garbage Burial In the Canal Zone

The garbage of Cristobal, Canal Zone, is disposed of by controlled tipping and burial. The active dump is limited in area, and depth is the most important measure in this system of garbage disposal, for it permits the utilization of the heat of combustion for the prevention and control of nuisances that are usually common to garbage dumps. Flies and rodents are conspicuous by their almost complete absence from the Cristobal garbage dump. Garbage disposal in Cristobal-Colon by controlled tipping and burial has proved entirely satisfactory from both a sanitary and financial standpoint for the past 12 years, although careful and intelligent supervision is of paramount importance for the success of this system of garbage disposal.

The cost per month is $145.83 for inspection (half time), $60 for foreman, and $760 for 13 laborers full time and 3 half time; a total of $965.83; or 54 cents per ton.[N 4]

Troubles in an Activated Sludge Plant

The activated sludge plant of Birmingham, Mich., design flow 1.5 mgd, has given good results, but some troubles have been experienced. The sewers are combined system; dry weather sewage is strictly domestic. Grit from the sewers in the settling tank hoppers (there is no grit chamber) so plugged the sludge withdrawal line that it was necessary to pump out the tank and remove ½ cu. yd. of grit.

In July, 1940, the larvae of the chironomid fly were so plentiful in the activated

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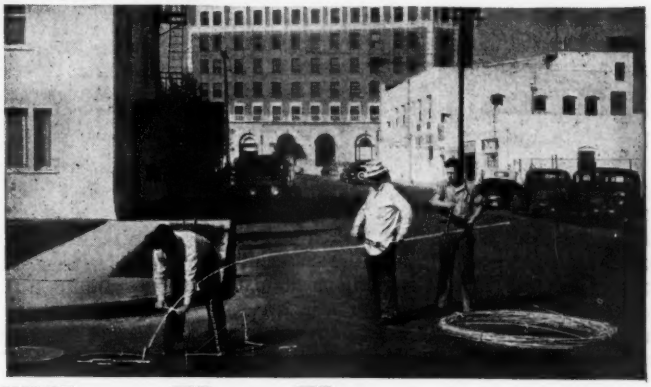

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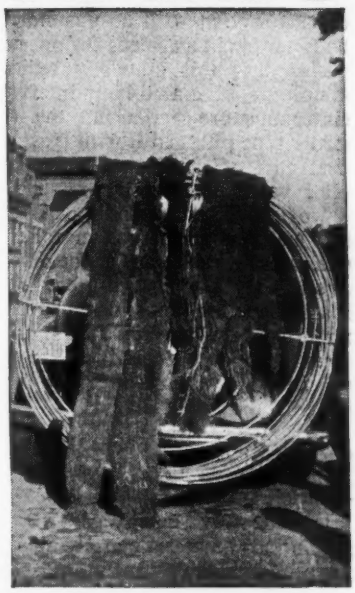

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sludge that poor settling was obtained in the secondary clarifiers. This was remedied by dosing the tanks with pyrethrum powder.

Digestion tank troubles.—The 2 digestion tanks operated in parallel satisfactorily for two months on primary sludge, but two days after a large excess of activated sludge was added they bulked and the supernatant contained 3% solids. Pumping sludge from the bottom of the tank into the top settled the sludge remarkably but bulking continued for 2 months. The digesters then were operated in series for 16 months, when sludge became so dense and deep in the secondary digester that the sludge-stirring mechanism would not operate; the bottom 3 ft. was so thick that pumps would not remove it (although only 10.3% solids), and it had to be diluted and stirred with water from a fire hose. Now sludge stirring and scum breaking mechanism is operated continuously, which gives more uniform rate of gas production and keeps scum thickness below 6″.

Gas production fluctuated from 16 c.f.m. to 2 c.f.m. and with no gas storage tank the latter is not sufficient for operating the gas engine; this is partly remedied by pumping sludge at 6-hour intervals. Last winter moisture carried into the waste gas burner pipe plugged it with frost crystals; recurrence of which was prevented by a relief valve opening if pressure exceeds 10″ of water. The winding of the Splitdorf magneto on the gas engine could not withstand the dampness of the pump room; substituting a moisture-proof American Bosch remedied this and improved engine performance. There was at first no condensation trap on the exhaust line, but one was found necessary and now removes a cup full to 2 gal. daily.[C 75]

Paint for Sewage Works

Due to Government use for defense, certain paint materials are temporarily almost unobtainable, including aluminum paste and zinc dust, oxide and chromate, certain resins, thinners and solvents. For the present the best obtainable substitutes must be used, and the Chicago Sanitary District in some cases attempts to provide only temporary protection to steel, hoping it will last until the war is over.

Of the several conditions at a sewage plant destructive of paint the most serious is the fog just above a sewage surface, which condenses on the paint, keeping it soaked more or less continuously and absorbing oxygen, hydrogen sulfide and carbon dioxide, thus becoming highly corrosive; also the alternate freezing and thawing of the moisture causes internal stresses.

A given priming paint may be good for use on steel under all conditions, but should be protected by coats particularly suited to the given exposure. In sunlight the best protection is afforded by aluminum or a good linseed oil or phthalate resin varnish paint. Below water the District applies a heavy coat of asphalt emulsion over the priming paint, having a dried thickness of 1/16 inch.[C 68]

Determining Grease in Sewage

The customary procedure involves evaporating the sample, which is time-consuming, especially with large samples, and subject to error with small samples. Experiments developed a method that gives consistent results, requires no evaporation and uses large samples; average variation between samples is less than 2%; the grease extracted contains no nitrogen and an average of only 2 ppm ash; the grease content of settleable solids before and after settling, as determined by this method, checks with the grease in the fresh solids collected. It consists of adding alum to a 4-liter sample, filtering through a Buchner funnel, remove adhering grease from both beaker and funnel, place all removed grease in a dish with HC1, extract with petrolic ether, distill off ether and weight; all according to a precisely outlined procedure.[C 72]

Drying Time For Sewage Samples

From experiments to determine the minimum drying time necessary to insure dryness of total and suspended solids, and the effect of prolonged drying, the Bird Island Laboratory concluded that "The standard procedure for determining suspended solids in sewage and total solids in sewage, digestion tank liquors, and sewage sludges should specify a period of drying of one hour in an oven at not more than 103 deg. C.[C 73]

Mallory Dairy Waste Treatment

A plant for treating the waste of the Eachus dairies at West Chester, Pa., was constructed in 1940, using the Mallory process, which is essentially the activated sludge process under precise mathematical design and control, supplemented by chemical precipitation when necessary. Each phase of the process is conducted in a steel tank above ground. In the former, aerated sludge is mixed with the sewage and the mixture is aerated, using perforated pipe air diffusers, passes down to a truncated sludge-collecting hopper, then up, is reaerated, and passes to the second tank. The design flow is 20,000 gpd and 100 lb. of B.O.D. per day. The blowers supply 120 cu. ft. of air per minute (8½ cu. ft. per gal. average). In the second tank alum is added, followed by lime. The final effluent passes through an aerator to a small lake. Excess sludge is digested in an unheated tank. Tested at 12,420 gpd flow with 92.4 lb. B.O.D., a B.O.D. reduction of 99.3% was obtained by the oxidizing stage; little further reduction was effected by using 17.3 lb. of alum and 5.8 lbs. of lime. In April, 1941, a test by the State Dept. of Health with a flow of 22,690 gpd and 180 lb. B.O.D. showed the B.O.D. reduced from 969 to 25 ppm in the first stage and to 6 in the final effluent; and from 890 to 18 and 5, respectively, with a flow of 15,-720 gpd and 117 lb. of B. O. D. The solids concentration of the mixed liquor is kept at 4%. Alum is adjusted by appearance of floc, and lime keeps the pH at 7.5.Tests are made regularly of pH, settling rates, solids concentration, relative stability and dissolved oxygen.[G 82]

Methods of Odor Control

"Psychological" odors are controlled by good housekeeping, attractive landscaping and development of good will.

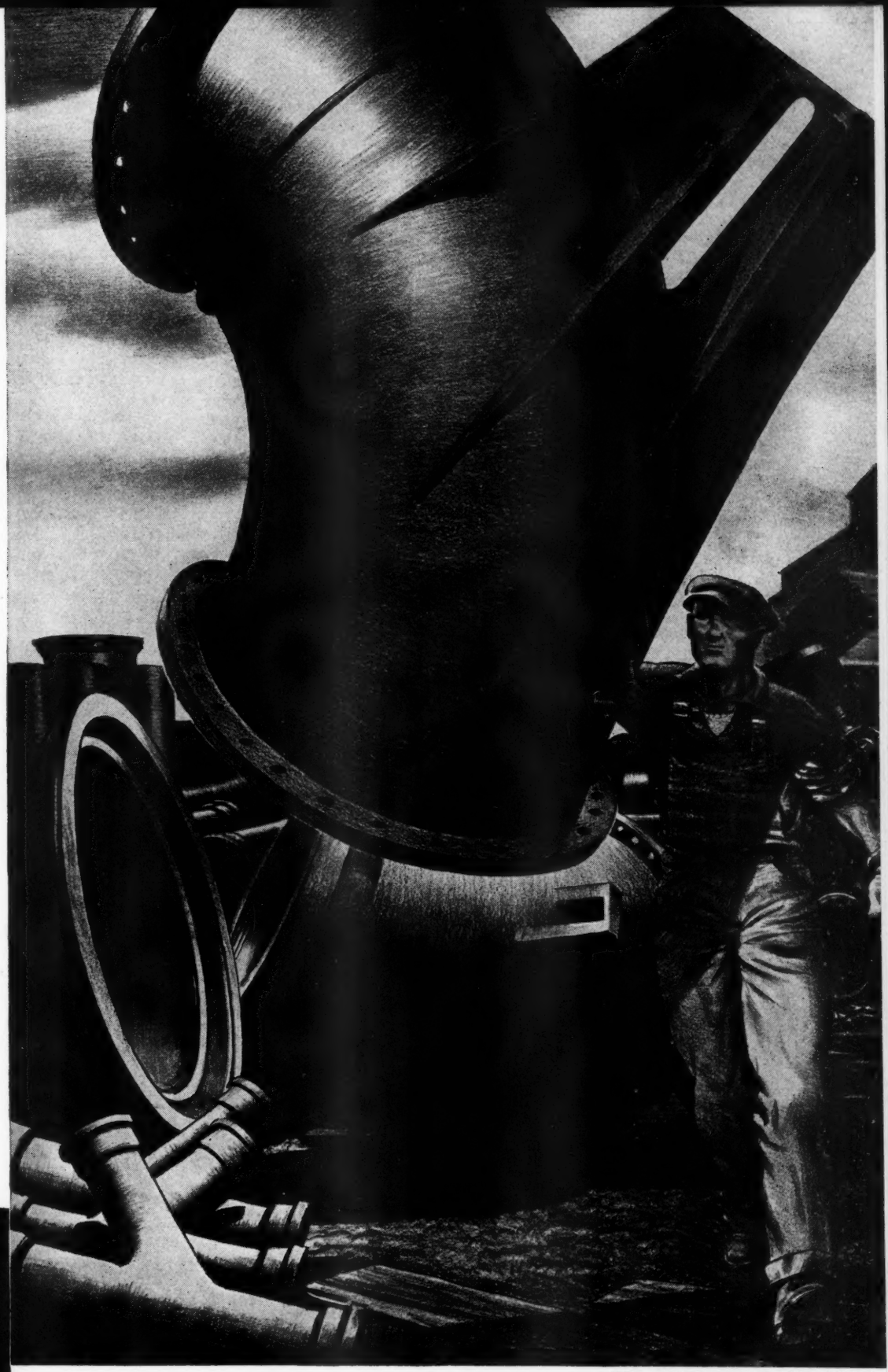
Hydrogen sulfide odors can be smelled in concentrations as low as one part in a billion, and may be carried several miles over low, flat terrain in the evening of a hot, humid day. The travel range of other odors is not nearly so wide. Odor is more common in trickling filter plants, especially if preceded by Imhoff tanks, than in activated sludge plants. Production of hydrogen sulfide is encouraged by 1—A high sulfur or sulfate concentration in the raw sewage. 2—Prevailing sewage temperatures of 70° F. or above. 3—Overlong detention time in the outfall sewer and primary units. 4—Sources of "seeding" of sulfate-reducing bacteria such as stale sludge deposits in sewers, channels and tanks, or supernatant from digestion tanks. Remedies that have proved effective include preliminary reducing or sulfate concentration or temperature of industrial wastes; increasing velocity of flow in outfall sewer by giving it free discharge at the plant; preliminary treatment or disposition of a strong supernatant by other means than return to the raw sewage. Maintenance of H_2S concentration below 1 ppm is considered adequate to control odors and corrosive effects.

Aurora, Ill. reduced detention time in primary tanks by using only 2 of its 4 tanks. Several cities turn water from stream into the sewer, thus diluting, increasing velocity, lowering temperature, flushing out deposits, and decreasing detention time in sedimentation tanks; doing this either continuously or at night or other times of low flow. Flint, Mich., draws fumes from an enclosed aeration unit by exhaust fans and discharges them to the trickling filter underdrains.

Chlorine is by far the most widely used odor control panacea at this time. (It also is used to give a stable primary sludge, improved digestion tank operation and filter fly control.) Activated carbon is used successfully at several plants.[C 76]

Sludge Disposal at Sea

Sludge from three large New York City treatment plants is discharged at sea about 12 miles from the Long Island and New Jersey shores and 34 miles from the Wards Island plant. Three boats were built especially for the purpose at $500,000 each and are operated by crews of 17 each; sludge capacity, 55,400 cu. ft. each. Investigation at this dumping site by chemists, bacteriologists and engineers determined that the most disagreeable effects from dumping arise at the time of dumping, disappear quickly and do not travel far. The water, examined over a 4-mile radius, quickly regains a normal condition and shows no signs of grease or persistent pollution. By detention in tanks, the activated sludge is concentrated from 0.5% solids to 2%, thus reducing the volume by 75%; and by decanting the sludge to the boats it is further concentrated to 3.88% solids. At one plant, chlorine is applied to the top water in the thickening tanks. Digested sludge at this



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plant (activated and primary sludges mixed) has an average solids content of 10.1%. At another plant only primary sludge is produced and it sometimes contains 18% solids and is pumped with difficulty. Sea disposal in 1940 cost, for operating and maintenance, $1.88 per m.g. of sewage, 10.5 cts. per wet ton or $2.40 per dry ton of solids.[G 28]

Sludge from the "Joint Meeting" plant in Elizabeth, N. J., which handles 28 mgd of sewage, concentrates sedimentation sludge of 5% to 6% solids, to 7% to 10% solids and barges it to sea; pumping it daily into 2 storage tanks of 626,000 gal. capacity each. The volume of this sludge stored at 70° F was reduced 18.3% in 24 hrs. and 46.4% in 96 hrs., but stored at 60°, there was much less change in volume, although it was possible to decant 25% to 30% of it. Sludge is pumped through 4,400 ft. of 24" pipe to a barge and dumped where New York City dumps hers. If the sludge is below 92% water it cannot be pumped, and is diluted by pumping fresh sludge or sewage into the tank; or by pumping sewage into the 24" discharge pipe to mix with the sludge on its way to the barge, which latter has proved most successful. Clogged pipes are cleaned by use of compressed air. Barging cost in 1940 was 24.5 cts. per ton; dock rental, labor and other costs increasing this to 32 cts., or $4 per ton of dry solids.

Sludge of New Haven, Conn., until July, 1940, was concentrated in tanks from 1½% solids to 10%, then barged 8½ miles into Long Island Sound and dumped in 75 ft. of water. There was some complaint of oil sleek and floating solids at the disposal area. Since July, 1940, the sludge has been incinerated.

Sewage from the Passaic Valley system is barged 28 miles to sea by the Merrit-Chapman & Scott Corp. under a five-year contract for 19.44 cts. per wet ton.[G 30]

Experiences With Sludge Gas

Los Angeles County, Calif., at times the gas from its digestion tanks insufficient to do all the sewage pumping, and last March connected a 1,000-gal. tank of butane to discharge directly into the gas area of the digestion tanks, where it mixed with the sludge gas. No changes were made in the gas engine, which "operated with perfect satisfaction on the combination fuel."[H 49] The Bakersfield, Calif., plant, when, 4 months after placing its digesters in operation, no gas formation had started, installed a butane system to heat water for the digester coils. In three weeks the sludge temperature reached 85° and 5 months later sludge gas began being used for this purpose.[H 52]

Scum Trouble In Buffalo's Digesters

During the second spring of operating the new plant of Buffalo, N. Y., scum with above 30% solids collected 8 to 10 ft. deep and could not be pumped. A spray was installed in the top of the gas dome by which water or supernatant can be distributed over the entire top of the scum; and the elevation of the scum was so arranged that a supernatant pipe came two feet below the top of the scum layer. When the scum had been sufficiently wet down it flowed into this pipe and was pumped to the incinerator or into another tank.[C 76]

Liquid Sludge As Fertilizer

Bottle Creek, Mich. sells secondary digested sludge as a liquid fertilizer for lawns, charging 1.1 ct. per gallon applied. A 3" pump is used to handle the sludge and does not clog as frequently as the 2" unit formerly used. Results obtained are remarkable and demand exceeds the supply.[C 77]

Chlorine Gas in Sewage

At Niagara Falls the sewage is mostly industrial, and chemical gases are almost constantly present, chlorine gas so predominating that the sewage is completely disinfected 25% to 50% of the time with use of chlorine equipment. A special chlorine operator, using close control and special testing methods, takes advantage of this and, by shutting off the chlorine equipment when additional chlorine is not needed, more than saves his cost.[H 53]

Flooding Filters For Fly Trouble

Cleveland floods its trickling filters in summer to control the Psychoda fly. This flooding is done over the week-end and is accomplished by throttling the effluent valves so that, during the flooding period, there is a constant flow of sewage through the filters.[H 57]

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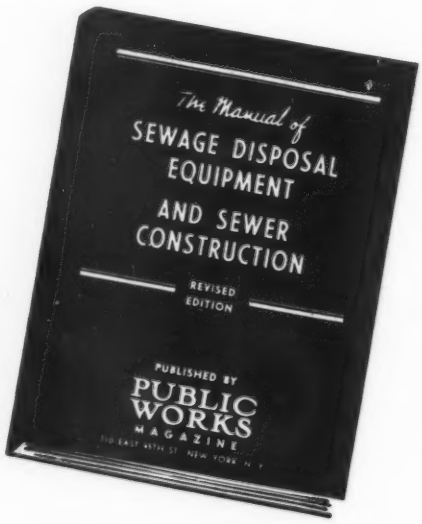

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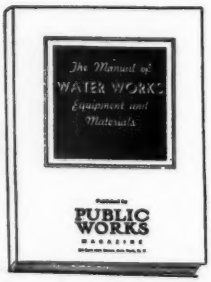

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c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

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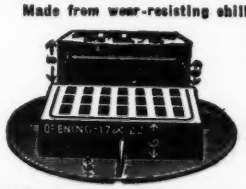

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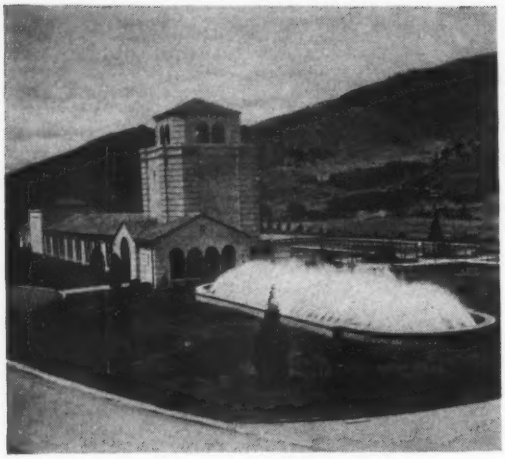


The Waterworks Digest

Abstracts of the main features of all important articles dealing with waterworks and water purification that appeared in the previous month's periodicals.

HOW TO FIND ORIGINAL ARTICLES. Key letter at end of each digest refers to name of publication listed in bibliography at end of this section. Numeral indicates title of article.

Water Priorities In Texas

Texas laws establish priorities in use of surface waters in the following order: "1. Domestic and municipal uses, including water for sustaining human life and the life of domestic animals. 2. Water to be used in processes designed to convert materials of a lower order of value into forms having greater usability and commercial value, and to include water necessary for the development of electric power by means other than hydro-electric. 3. Irrigation. 4 Mining and recovery of minerals. 5. Hydro-electric power. 6. Navigation. 7. Recreation and pleasure."[X 48*]

Maintaining Valves in Omaha

The Omaha, Neb., distribution system contains about 5,300 valves on 525 miles of 4" to 48" main. All 16" to 48" valves are operated through a closing or opening cycle at least once a year on a maintenance schedule. All the larger valves at the main pumping station are operated every 6 mos., and to determine whether closure is complete, a small waste valve is opened to relieve the pressure on one side and note leakage if any. During maintenance operation of the valves, the number of turns required to open or close is noted, usually with a mechanical counting device; packing is tightened, gears and bearings lubricated. For operating valves 16" and larger use is made of a valve-operating equipment developed in the department's shops which consists of a light car differential connected to the power take-off of the repair truck, and to a 1½ ton truck differential installed in a vertcial position on the side of the truck so that a vertical hexagonal operating shaft may be passed through it.[F 88*]

Laying Main In Record Time

In order to supply water to an Army ammunition plant near Denver, Colo., the water department of that city laid 1½ miles of 14" and 12" main from its 63" steel supply line and turned water into it seven days after the Army engineers reached a decision as to what they wanted —*immediately;* (after which rush the water was not used for about a month). Decision was reached Feb. 14th; next day there were 60 men on the job (besides 25 hauling pipe) increased to an average of 70 for the week, working 10 hrs. a day. Four crews laid pipe at 4 different locations, using three trenching machines, two backfillers and an air compressor. The line crossed a major paved highway, an interurban electric line, a jackhammer was used on some shale and there was one 18 ft. cut. Water was turned into the line Feb 21, although the backfilling had not yet been completed. The cost of this line, $34,512.90, was paid by the government, but this is paid back by the Water Dept. refunding 50% of each month's water bill, which is to be based on the regular meter rates charged consumers outside the city. The department agrees to furnish an amount of water equal to that used by the city of Denver; to insure which, it is instaling two 5 mgd pumps drawing water from another source, which will be piped about 4 miles to the ordinance plant.[F 87*]

Stopping Leaks In a Subaqueous Main

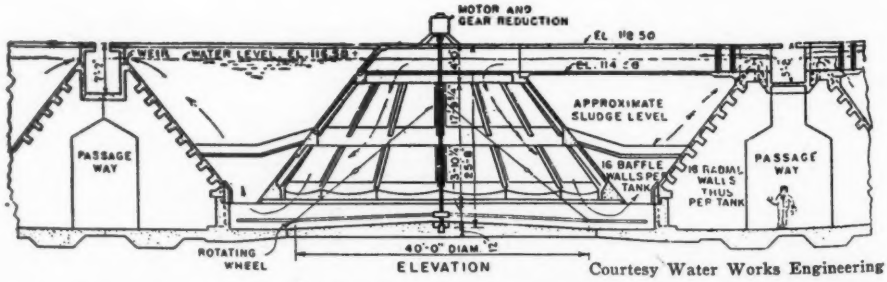
A 14" main under a river at Saginaw, Mich., 1,400 ft. long and containing 128 okum-lead b & s joints, leaked 421 gph. when first laid, which fell to 200 after two years of service. To reduce this, the water in the main was displaced with air; then the main was filled with a solution of sodium silicate and aluminum sulphate, with some powdered asbestos to act as a filler, and a pressure of 15 lb. applied, which was increased at the rate of 5 lb. per hour until 85 lb. was reached, which was maintained for 5 hrs., when all leakage ceased. The solution in the main was then replaced with one of calcium chloride, which in turn was flushed out. Water hammer started a leakage of 5½ gph. but two years later it was zero.[E 15*]

Ozone Reduces Odors and Tastes

The water supply of Whiting, Ind., 11,000 population, is from an industrially polluted source having a hot threshold odor that has reached 275. After spray aeration, filtration, ammoniation and chlorination the hot threshold odor still averaged 15 and often reached 40. Ozone has cut this to an average of 11 and maximum of 20. An ozone plant with a capacity of 50 lb. per day, costing $30,000, was guaranteed to reduce the odor 80% when that of the raw water was between 30 and 75, and not to exceed 15 if the raw exceeded 75. The cost, including interest and amortization, chemicals and maintenance, is estimated at $4.44 per m.g.[E 13*]

Softening At Minneapolis

A 120 mgd. softening plant at Minneapolis went into full operation June 10, 1941. Water is taken from the Mississippi river with hardness, by monthly averages, ranging from 150 to 206 ppm in calcium carbonate, which is to be reduced to 75 ppm. Color averages 35 ppm, reaching a maximum of 150 for a short period. Normal treatment can control only 90 to 100 ppm of color, and pre-color removal will be necessary about 7 days a year. The city



Courtesy Water Works Engineering

Elevation of a typical precipitator as installed at the Fridley plant, Minneapolis

*See Bibliography in the October issue.

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has two filtration plants, at Columbia Heights and Fridley; the softening plant is at the latter, the softened water then being divided between the two plants (which are 3 miles apart) for filtration and chorination. When the color is high, all the water goes first to the Fridley coagulation basins, where color is reduced by alum treatment to 60 or 70 ppm, then to the softening plant where the color is further reduced.

Extensive experimental work prior to construction led to the adoption of the Spaulding precipitator, twelve of which were provided. The plant also includes a low-service pumping station, chemical house, carbonation chambers, sludge concentrators, disposal beds, and slakers, feeders and other mechanical equipment. Chemicals are unloaded from cars to bins by pneumatic conveyors and distributed by screw conveyors.

Pumping, softening and repumping are controlled at a central dispatcher's station by electrical remote control. Green and red lights show when control gates are open or closed. The chemical operators similarly have remote control of the feed of lime and other reagents. The precipitator effluent is satisfactory when cold but precipitates carbonates when hot and hexametaphosphates are being tried. Cost of filtration and softening is about $22.82 per mg. As filtering alone in 1940 cost $14.30, softening costs about $8.52. In June, 1941, soda ash was used 17 days, copperas 6 days, alum 21 days.[F 97]

Chemical Aspects of Breakpoint Chlorination

The residual curves obtained by chlorinating water follow one of three general types, depending upon the character of the water. The magnitude of the breakpoint curve and the amount of chlorine required to produce it depend to a large extent upon the amount of free ammonia in the water. At breakpoint both N and chlorine, as residual chlorine, are lost. The speed and extent of the reaction are dependent to a great extent on the pH of the solution, the optimum of which for plant practice lies between 6.5 and 8.5. The time of contact is of considerable importance in the completion of the reaction. The ratio of N to chlorine at the optimum pH to reach the breakpoint is 1:10, which may extend to 1:25, or beyond in natural waters. Chloramines are formed in the area of the hump and are more stable in the presence of an excess of ammonia than in an excess of chlorine. Apparently monochloramines are formed at pH 9.0 and dichloramines at pH 5.0.[B 32]

Sanitary Significance Of Coliform Bacteria

There are two distinct sections or genera of B. Coli; the *Aerobacter*, of which aerogenes is the type species, and the *Escherichia* genus, of which *coli* is the type species. The latter are typical intestinal parasites of man and animals, whereas *Aerobacter* are infrequently isolated from intestinal contents but consistently found in soil and cereals. Also a non-pigmented gas-producing strain of *Serratia* cannot be distinguished by any known method from *Aerobacter*. It is evident, then, that the appearance of gas in a lactose broth tube in 48 hrs. is not an absolute criterion of the presence of a member of the coliform group and even less a criterion of fecal pollution.[B 30]

It is probable that many epidemics of diarrhea or mild dysentary have been due to treated sewage polluted water ("marginal" water). The author presents data to show that opinions as to the presence or absence of coliform organisms in marginal waters is arbitrarily based on the selection of the medium used for their isolation and not on their actual presence or absence; indicating "a greater need of close supervision of marginal water supplies to be sure that epidemics of water-borne diarrhea and dysentery are avoided." Water works operators, particularly those handling marginal supplies, should attempt to make their treatment processes so effective that no coliform organisms are ever found in the finished water.[B 31]

Atlanta's Filter Plant Additions

Atlanta, Ga., in 1893 built a pressure filter plant, extended as such until 1922, when gravity filters were built of 21 mgd capacity. By 1938 maximum consumption had reached 65 mgd and additional filter and sedimentation capacity were needed. Funds were limited and as it was possible to filter well-settled water at a rate of 3 gal. per sq. ft., only 33 mgd additional filter capacity was provided, and 8 mg sedimentation basin capacity. At present the plant has a normal capacity of 72 mgd, of which 18 mgd is obsolete pressure filters. The maximum consumption is 55 mgd.

In the new filters all pipe larger than 6″ is welded steel, with welded joints in the pipe gallery field except that mechanical couplings are used every 40 ft. and at other points to permit removal of valves, etc. Exposed pipe and fittings in the gallery were lined with 1/16 in. of hot bitumen tested for holidays at 15,000 volts, painted outside with red lead and aluminum paint. Filter laterals are 3″ cast iron cement-lined with a seal coat, between which are Wagner blocks. Half-inch copper pipes reach from the laterals to above high water level for releasing entrained air. All main control valves are either hydraulic gate valves or hydraulically or manually operated cone valves.[G 41]

Philadelphia's Water Supply Program

Voters of Philadelphia, Pa., have approved a bond issue for improving existing facilities for purifying water from the polluted Delaware and Schuylkill rivers rather than spending $150,000,000 to $300,000,000 for obtaining a supply from a distant, less polluted source. The program included rehabilitation of the existing works and modernization of the supply facilities to furnish safe and potable water; and improvement of the transmission and distribution systems, involving both pumping equipment and mains; designed for a future of 25 years, if waste is eliminated.[L7]

Bibliography of Waterworks Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

B *Journal, New England Water Works Ass'n.*
September

29. Design and Construction of Pressure Aqueduct for Boston Metropolitan District. By Stanley M. Dore. Pp. 315-354.
30. *t.* Sanitary Significance of the Coliform Bacteria in Water. By C. A. Stuart. Pp. 355-362.
31. *t.* The Bacteriological Detection of Health Hazard in Water Supplies. By W. L. Mallman. Pp. 363-370.
32. *t.* Some Chemical Aspects of Breakpoint Chlorination. By A. E. Griffin and N. S. Chamberlin. Pp. 371-383.
33. Toxic Contaminants of Drinking Water. By L. T. Fairhall. Pp. 400-410.
34. Determination of Comparative Efficiencies of Filter Washing. By J. Wuraftic. Pp. 411-430.
35. Military Field Sanitation. By W. A. Hardenbergh. Pp. 431-437.
36. Emergency Protection of Public Works and Utilities. By W. W. Brush. Pp. 438-457.
37. Cooperation of Fire and Water Departments in Planning for Emergencies. By S. J. Pope. Pp. 458-462.
38. Length of Service of Water Works Facilities—Knowledge or Guesswork? By R. Newsom. Pp. 463-472.
39. The Saugatuck Development of the Bridgeport Hydraulic Co. By S. P. Senior. Pp. 473-474.
40. The Water Supply of Lunenburg, Mass.; or Can My Town Afford a Public Water Supply? By H. E. Bailey. Pp. 475-481.

E *Engineering News-Record*
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18. *t.* An Engineer's Approach to Fluid Mechanics. By A. Ellwood. Pp. 87-91.

F *Water Works Engineering*
September 24

97. Softening Water at Minneapolis. Pp. 1204-1208.
98. Meters Increase Revenue at Hickory, N. C. By H. V. Linden. Pp. 1209-1211, 1230.
99. Restoring Well Yield. Pp. 1220-1221.

October 8

100. Supplying Water to 30,000 Troops. By S. M. Ellsworth. Pp. 1260-1263, 1265.
101. Sulfuretted Water Supplies City. By L. K. Kopriva. Pp. 1264-1265.

G *Water Works and Sewerage*
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38. The Meter Master. By D. R. Taylor. Pp. 375-378.
39. Meter Room of Danvers, Mass. By R. W. Esty. Pp. 379-381.
40. *p.* Legal Responsibilities of the Water Works Operator. By J. H. Murdock, Jr. Pp. 418-421.

October

41. Modernization and Enlargement of Atlanta's Filter Plant. By H. F. Wiedeman and P. Weir. Pp. 435-441.
42. *p.* Relation of Meter Rates to Distribution System Conditions. By C. H. Capen, Jr. Pp. 473-476.

J *American City*
October

21. Zeolite Water Softening with Anti-corrosion Control. Pp. 50-52.

K *Proceedings, American Soc. of Civil Engineers*
October

3. *t.* Effect of Suspended Solids on Characteristics of Centrifugal Pumps. By L. C. Fairbanks, Jr. Pp. 1422-1433.
4. *t.* Mechanics of Flow with Non-colloidal, Inert Solids. By W. E. Wilson. Pp. 1434-1444.

L *Civil Engineering*
October

7. *p.* Philadelphia Decides on Water Supply Program. By N. B. Jacobs. Pp. 606-609.

P *Public Works*
October

46. Solving a Difficult Water Supply Problem. By R. Lynch. 15, 44.
47. Developing the Beatrice, Neb., Water Supply. By J. A. Terhune. Pp. 21-22.
48. *n.* Cutting Cast Iron Pipe With a Punch. P. 26.

Y *Pipe Progress*
October-November

1. Cast Iron Pipe Laid on Piles Across Alluvial Marsh. By J. E. Gibson. Pp. 1-3, 14.

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Keeping Up With New Equipment

Silver Anniversary of Barber-Greene Company

The Barber-Greene family—one thousand strong—celebrated the 25th Anniversary of the founding of the company October 21, 1941, at a banquet and evening packed with entertainment and camaraderie. Members of the company as well as outside performers entertained the employees, their wives and husbands.

Theme of the celebration was expressed by W. B. Greene, vice-president and treasurer and co-founder of the company, in the introduction to his "History of Barber-Greene To Date," an illustrated talk full of anecdotes and philosophy.

"We are not celebrating age or size," Mr. Greene said, in part. "We are celebrating loyalties and personal relationships, and a contribution to the industrial and social life of the nation. Products unique answering specific needs that have helped to raise the nation's standard of living; helped to shift human service from long hours of back-breaking toil to shorter hours of more skilled service; tending to greater human dignity and greater life satisfaction for all."

Founded by Harry H. Barber and William B. Greene when the first World War flamed over Europe, Barber-Greene has been playing a major role in the second World War. Its labor and time-saving equipment—bituminous mixers and finishers, bucket loaders, conveyors, ditchers—are extensively used, both here and abroad, in war and national defense work.

Theme of the future of the company was given by Ashley Barber, son of H. H. Barber, and an active officer in the company today. Mr. Barber stated, in part, "We cannot judge our future by the prospective market for Barber-Greene products of today. As important as these products are, the last twenty-five years have made Barber- Greene bigger than the equipment it provides the field.

"Its success in the future will be due to its ability to visualize changing needs, provide new answers, then manufacture, sell, and operate on the highest possible plane. Barber-Greene's future, then, is its organization together with its fundamental policies.

Emergency Water Equipment Demonstrated

Wallace & Tiernan Co., Inc.
Newark, N. J.

A demonstration of emergency water purification . . . as it might have to be carried out to protect New Yorkers from water-borne disease in the case of damage to the water system from bombs, explosion or sabotage, was carried out recently before prominent officials of New York City's Department of Water Supply, Gas and Electricity, in Battery Park, New York City.

The equipment used for this demonstration consisted of the new trailer-type mobile chlorinating unit recently developed by Wallace & Tiernan Co., Inc., Belleville, N. J. The unit has special facilities for hooking up to broken mains, etc. Many of its features have been incorporated as a result of experience gained in safeguarding water in "blitzed" English cities.

Stormy weather is completely ignored as Wm. H. Correale, First Deputy Commissioner, New York City Department of Water Supply, Gas and Electricity, questions Alan Johnstone of Wallace & Tiernan Co., Inc., about the details of W & T's new mobile water sterilizing unit.

The demonstrator of the equipment was Alan Johnstone, Sales Engineer of Wallace & Tiernan. Among the interested observers from the Department of Water Supply, Gas and Electricity were:

Wm. H. Correale, First Deputy Commissioner.

Richard A. Ankener, Deputy Commissioner.

Wm. Flannery, Chief Engineer.

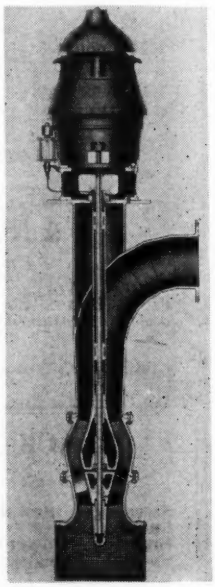
Dr. Frank Hale, Director of Laboratories.

Edward Clark, Engineer.

Propeller Pumps for Biofiltration Systems

Fairbanks, Morse & Co.
600 So. Michigan Ave., Chicago, Ill.

As the heart of the Biofilter Plant is the high capacity, low-head pumping required in the recirculation system between the Biofilter and the detention tank, the Fairbanks-Morse line of mixed flow propeller pumps in the Figures 6310 and 6360 series, which are admirably adapted for this service, are described in a new bulletin just announced.



Propeller Pump for Biofiltration Plants.

The recirculation, which is a distinctive feature of the process, supplies the means whereby the liquid is rapidly passed through the filter bed in addition to being retained in the tank for the required period.

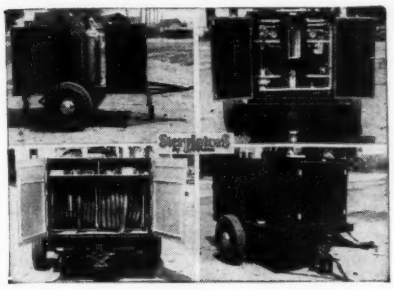
The bulletin points out among other things that the Fairbanks-Morse Figures 6310 and 6360 vertical propeller pumps may be arranged for electric motor, Diesel or gasoline engine drives.

The Dorr Company, Inc. and the Link-Belt Company, chief licensees of Harry N. Jenks, Consulting Sanitary Engineer, Palo Alto, Calif. who developed the Biofiltration process, furnish the general sewage works equipment used in plants of this type, while Fairbanks, Morse & Co. pumps are a very important part of the system.

Bulletin 6301 describing both the system and pumps for the Biofiltration Process may be had by writing the headquarter's office of Fairbanks, Morse & Co.

Steel Form Catalogue

Blaw-Knox Company (Pittsburgh, Pa.) has issued a new bulletin, No. 1828, on steel street forms. It presents diagrammatic sketches and photographs of form installations for concrete curb, curb and gutter, integral curb, sidewalks, gutters, flexible and fixed radius forms, etc. Optional form designs are presented for each type of work.



Everson SterElator.

Portable Chlorine Gas SterElator

Everson Manufacturing Co.
Chicago, Ill.

Everson Manufacturing Co., Chicago, makers of Everson SterElators and other water sterilizing and filtering equipment, announces a new portable chlorine gas SterElator of military type. This portable field sterilizing plant is mounted on a pneumatic tired trailer and is complete with manually operated SterElator, self-priming pump, intake and outlet hose and racks for 4 standard high pressure drums of chlorine.

Norgahn Moldboard Glaze

The Norgahn Co.
604 Eleventh Ave., S., Wausau, Wis.

This is a new material used on the moldboard of snow plows, which prevents wet, sticky snow from adhering to the surface and cuts down, to a great extent, the resistance of snow to the moldboard. It is semi-liquid and can be brushed or swabbed on the surface of the moldboard without heating and regardless of the temperature of the metal at the time of application. And can be easily applied right in the field.

Another product developed by this company for snow plows is Wingslide compound. This is a form of lubricant for the wing slides of snow plows which is impervious to snow and water. The manufacturers claim it will adhere to the metal where ordinary greases will wear or wash off. These materials have been in use for two seasons and the manufacturer says have received enthusiastic praise.

Gardner-Denver Sewage And Waste Disposal Pumps

It is claimed Gardner-Denver Type J and K pumps incorporate all of the latest technical improvements and features of design proven in the field. The particular requirements of pumps to handle large size solids has been carefully analyzed and these pumps built to meet the most exacting requirements. The impeller and casing are specially made for handling solids.

In some services the pumps must not only be able to handle the solids in the fluid but also the fluid may be corrosive or the solids may be of an abrasive nature. And while the standard construction is cast iron impeller and casing and bronze wearing rings, shaft sleeve and impeller screw; the pumps are also regularly furnished of all iron, all bronze, stainless steel, abrasion resisting steel and other metals as required by the particular service. Write Gardner-Denver Co., Quincy, Ill., for Catalogue A-304 giving complete specifications.

White Cement Reduces Highway Accidents

Trinity Portland Cement Co.
111 W. Monroe St., Chicago

"White cement has assumed an important place in the war against highway accidents," said Paul F. Keatinge, Manager of the White Cement Department of the Trinity Portland Cement Company, recently in discussing the highway safety problem.

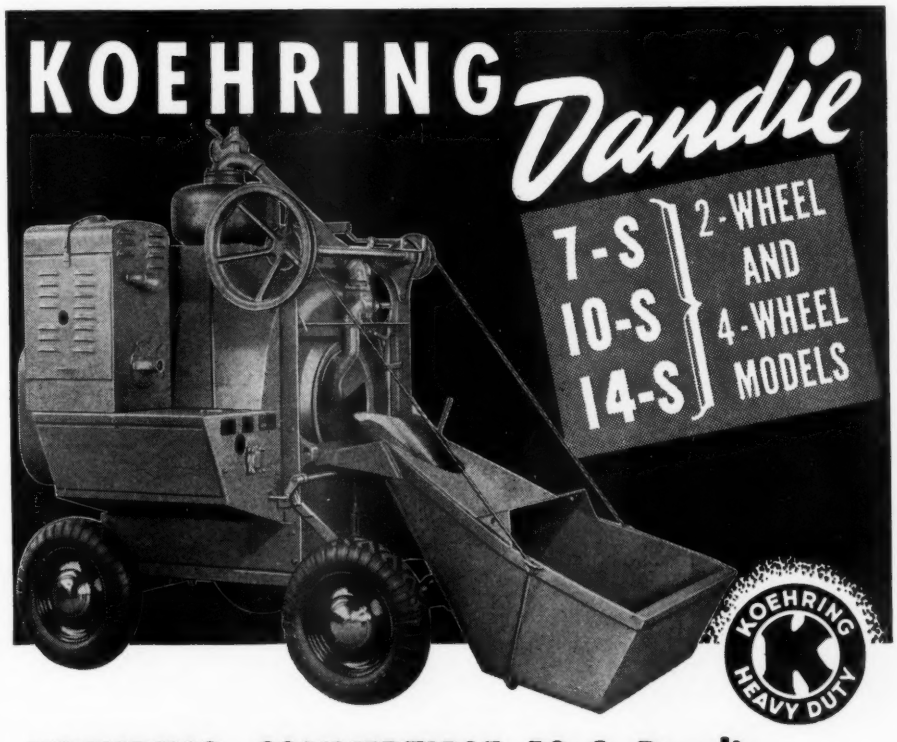
"The high speed of motor traffic, particularly on multilane roads where traffic has not been separated, has emphasized the importance of safe guidelines.

"The greatest contribution to safety in this respect are the light reflecting curbs that have been built in a number of states but particularly New Jersey and New York.

"These reflecting surfaces are naturally most effective at night, when the rate of accidents is higher and their record where they have been installed, is particularly good.

"They also provide a safe guide in daylight and are a practical solution to this problem in congested areas where it is impossible to separate traffic lanes as has been done in rural districts where land values are low.

"White cement has also been used for several years at street intersections to



KOEHRING CONVERTIBLE 10-S Dandie

. . . side or end discharge. The change is quickly made in the field to suit pouring conditions. Important and new is the rubber-tired drum roller which provides quiet and smooth operation. Other special features are easily accessible: drum drive shaft, flow line discharge chute and simplified skip-flow shaker.

● Other popular sizes are the 7-S Dandie Trail-Mix and the 14-S 4-wheel Dandie . . . side or end discharge . . . air-cooled engine . . . anti-friction bearing . . . multiple "V" belt drive . . . enclosed reduction gear assembly running in oil.

KOEHRING CO., MILWAUKEE, WIS.

HEAVY-DUTY CONSTRUCTION EQUIPMENT

Barber-Greene Tamping-Levelling Finisher.

direct pedestrian traffic. The guiding lines, when built in this manner, are permanent and maintenance free."

Speed in Construction of Airport Runways

BarberGreene Co.
Aurora, Ill.

Expansion of existing airports is an important function of the Defense Program. Here the runways of the Madison, Wisconsin, Municipal Airport are being widened and lengthened. The speed of bituminous construction is being utilized on many such jobs.

Payne & Dolan of Wisconsin is using the Barber-Greene Tamping-Levelling Finisher shown above for laying a 2" mat 150' wide over a limestone base. The project totals 10,000 tons, about half of which was completed when this picture was taken.

Over 120 students are enrolled at Madison, one of which is shown taking off from the old stretch of runway in the background.

Flexlock Corporation

Exclusive Distributors of Flexlock Rubber Gaskets

J. H. Connors, vice president in charge of sales of the Mechanical division of The B. F. Goodrich Company, announces Flexlock Corporation has been formed and given exclusive distributorship for the patented Flexlock rubber gasket manufactured by the company.

T. D. "Duke" Nathan, inventor of the gasket, who has been engaged in sales engineering for the Goodrich company in connection with the product since 1934, is General Sales Engineering Manager of the Flexlock Corporation, 411 East Market St., Akron, Ohio.

The gasket is designed so that pipe couplings can be assembled simply and easily in the field and at the same time provide a seal that is not disturbed by any new conditions on the pipe.

Like a rubber band, it is laid over the lip end of the pipe. It is provided with a number of circumferential ribs which fold into place when the next section of the pipe is forced over them, locking the two lengths firmly together. These ribs resist pressure thrusts and soil stresses from any angle.

The sizes range from ¾ inch to 108 inch pipe, and can be applied to pipe of any composition, including iron, copper, brass, reinforced concrete and vitrified clay.

The gasket is designed for either light duty or pressure couplings. The light duty couplings have found their principal uses in irrigation piping, sanitary lines, sewer lines, and low pressure water lines, while the high pressure couplings have been installed in municipal and industrial water systems, etc.

The gaskets are made in either natural or synthetic rubber, the latter having special application on oil lines where the solvent action might affect the natural rubber, but leave the synthetic unaffected.

Modern pH and Chlorine Control

This is the title of a new edition of the handbook published by that company which the publishers claim gives in simple language all of the information needed for the practical application of pH, Chlorine and Phosphate control and for water analysis. It describes all Taylor outfits with complete instructions for operation and a simple explanation of the meaning of pH control, the precautions which must be observed in making determinations, etc. Copies of this handbook may be had by writing W. A. Taylor & Co., 2300 York Road, Baltimore, Md.

Due to the greatly increased business, this company has found it necessary to erect a new and modern building which was designed to take care of their specific requirements. It is a handsome brick structure of excellent architectural design. The architect, after thorough consultations with the officers and their technical assistants, planned the interior so as to embody every modern improvement necessary to the greatest efficiency in manufacturing the product of that company.

"S-P" Steel Service Pipe, Coated and Cement Lined

Hill, Hubbell Co.
Cleveland, Ohio

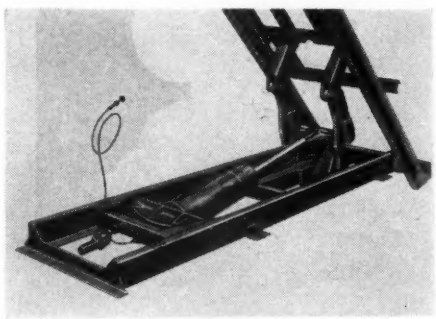
To relieve the shortage of galvanized pipe and copper tubing, the Hill-Hubbell Process is now being made available in "S-P" steel service pipe. Hill-Hubbell exterior "factory processed" coatings are available in sizes from ¾" to 1½" with special interior cement linings. Regular water works enamel linings and coatings are available in sizes from 2" and up.

The manufacturers say "S-P" service pipe follows the approval in 1940 of the American Water Works Association of specifications 7A.6-1940, dealing with "shatter-proof" steel water mains in sizes from 4" to 30".

Heavy Duty Super Hoists

Anthony Company
Streator, Ill.

So successfully has the Super Hydraulic Hoist design performed for the past several years that the Anthony Company now announces that their complete line of Hydraulic Hoist Dump Bodies in capacities from 5 to 30 tons will be of the Double Arm "Super" Hoist design. This announcement means that the entire line from the smallest to the largest, including Single Cylinder and Twin Cylinder Models, will have the "power speed" feature, which makes the Super Hoist so noticeably more powerful and fast. Also through the use of "Balanced" piston type of control valve the complete line will be equipped with latest "Push-Pull" dash control. The patented hoist design permits the exclusive use of "Rubber Restraining Blocks" (Pat. Pend), which replace awkward old-fashioned restraining chains and springs. Other features of the Super Hoist design are Telescopic Tipping and Subframe for "lower mounting" and greater load and truck stability; unit construction which makes the entire dump body unit independent of the truck chassis and uses the chassis for nothing other than to carry the load. For further particulars and catalogs describing these Super Hydraulic Hoists, address the Anthony Co., Inc., Streator, Illinois.



Anthony Heavy Duty Super Hoist.

Improved Stability Indicator

Phipps & Bird, Inc.
Richmond, Va.

Phipps and Bird, Inc. announces a new and vastly improved model of the Enslow Stability Indicator.

This apparatus, conceived by Linn H. Enslow, provides a continuous corrosivity or stability index with the fewest possible number of operations and minimum time requirement. It has been completely redesigned to embody several features which were suggested and developed by practical waterworks men from tests made under actual plant operating conditions.

Two outstanding improvements are, a constant head tank and a specially designed calcium carbonate contact cham-

ber, which holds a charge of precipitated chalk.

Other new features include an air-bleeder on the primary trap tube to preclude pressure build-up and possible cracking of the tubes. Adjustable metal clamps, which hold the rubber stoppers securely in these tubes, represent another improvement of practical merit.

For further details and descriptive literature, write Phipps and Bird, Inc., Laboratory Supplies, Richmond, Virginia.

Layne & Bowler, Inc. Increases Manufacturing Facilities

Once more Layne & Bowler, Inc. of Memphis, Tennessee, have found it necessary to erect new buildings for speeding production through the plant. The latest is an entirely fireproof all steel pipe and screen shop, adding 8800 square feet of new manufacturing space for use in making well water screens and welded pipe.

Straight line fabrication has been adopted, thus placing in one building all machinery required in the making of well water screens and pipes. Production has been increased over twenty-five percent.

Layne & Bowler, Inc. and affiliated companies say they have broken all time records in the number of wells installed and the amount of water produced for defense projects. Large contracts for additional Government work have necessitated increased production throughout the entire plant.

Data on Douglas Fir for Bridges and Other Structures

Flat Top Roof Trusses of Douglas Fir, Blue Ox Series, No. 2, presents a series of design examples of roof trusses for 40-foot, 60-foot, 80-foot and 100-foot spans, with bills of material, and analysis of several joints showing design procedure and the governing factors in the calculation of ring connectored joints.

Strengths of Lag Screws in Douglas Fir, Supplement No. 3, to the Douglas Fir Use Book, contains tables of safe loads on lag screws in Douglas fir based on Technical Bulletin No. 597 of the U. S. Department of Agriculture, Forest Products Laboratory, Forest Service.

The Scholten Nomograph for solution of the *Hankinson Formula,* Supplement No. 4 to the Douglas Fir Use Book, gives two charts for determining the bearing strength of wood on wood, and of bolts, lag screws, pins, etc. on wood, at any angle to the grain.

Copies of these publications may be obtained without charge from the West Coast Lumbermen's Association, Stuart Building, Seattle, Washington.

"Liquid Chlorine" (6th Edition)

Pennsylvania Salt Mfg. Co.
Widener Building, Philadelphia

The Company says the demands for the previous editions have been so great that a new reprinting was necessary. The desire to keep this publication up to the minute by including new information caused a general rewriting of this, the 6th edition.

Particular attention is directed to the cover endeavoring to depict today's scientific concept of the chlorine atom structure. This is the result of much discussion among atomic physicists, within and without our Company, on just how the chlorine atom should be illustrated. The added information on improved water chlorination practice and the appendices, discussing the whys and wherefores of chlorine taffy and what we are doing about it, will be of special interest to public health workers.

Inquiries for additional information will receive prompt attention.

Sanitary Engineering Lubrication

Fiske Brothers Refining Co.,
129 Lockwood St., Newark, N. J.

In an 8-page, well illustrated folder, this company gives information of interest to the operators of sewage disposal and water works plants in regard to lubrication which is interesting and valuable.

The manufacturers claim that "Lubriplate" maintains a wear-resisting, load bearing film on shafts, bearings, gear teeth, chains and other contacting moving machine parts, and arrests progressive wear.

Write for a copy of "Lubriplate" film No. 4-41.

The basic Mathews principle of a removable barrel containing all operating parts is now 75 years old. It cannot be improved upon, for the elbow and protection case are permanently in the ground, yet the hydrant can be repaired, replaced, overhauled, modernized, raised, or lowered, from above ground, with *no* digging. Note that the barrel screws tight into the elbow at (1) while a loose frost casing (2) allows it to be removed complete with main and drain valve and their seats (3).

Write for detailed description, demonstration, or prices.

MATHEWS HYDRANTS
***Made by* R. D. WOOD COMPANY**
Manufacturers of Sand Spun Pipe (centrifugally cast in sand molds) and R. D. Wood heavy-duty gate valves for water works
400 CHESTNUT STREET, PHILADELPHIA, PA.

When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 55-57

PEOPLE . . . *Here and There*

Chris J. Sherlock to Head American Road Builders Assn.

Chris J. Sherlock, Alabama's 43-year-old state highway director, has received the nomination as president of the American Road Builders' Association, the nation's No. 1 highway organization. The nomination is tantamount to election. Mr. Sherlock will be installed at the 1942 convention of the association in Memphis, Tenn., the week of March 2. He will succeed Hal G. Sours, director, Ohio Department of Highways, Columbus.

Mr. Sherlock is a native of Americus, Ga., and a graduate of Georgia Tech. He is married and has three children, a member of the American Legion, the Catholic Church, Kappa Sigma Fraternity and was recently elected vice-president of the American Association of State Highway Officials.

A.R.B.A. Convention

American Road Builders Association announces that the 1942 Convention will be held at Memphis, Tenn., during the week of March 2nd.

Highway Research Board Meets in Baltimore December 2-5, 1941

The Highway Research Board announces that its Twenty-first Annual Meeting will be held at Johns Hopkins University, Baltimore, Maryland, the first week of December, 1941.

On Tuesday, December 2, several Departments of the Board will hold open meetings for the consideration of papers and reports.

Yeomans Appoints Carl E. Schwob Chief Sanitary Engineer

Carl E. Schwob, former principal sanitary engineer, Division of Sanitary Engineering, Illinois State Department of Health, has been appointed Chief Sanitary Engineer in charge of the sanitation equipment department of Yeomans Brothers Company, Chicago.

Mr. Schwob is a graduate in sanitary engineering of the University of Iowa, 1926, with a master's degree from Harvard University, 1938, and has had fifteen years' experience in sanitary engineering and kindred fields.

Chain Belt Co. Promotes Viall, Devine, Thomas and Others

G. K. Viall, Vice President of Chain Belt Company of Milwaukee, has been appointed as head of a new Division of Research and Development now being organized by the Company. Mr. Viall has been connected with Chain Belt Company since 1921 in various capacities, including Chief Engineer Chain Division, Assistant to the President and Works Manager. In assuming his new position, he will also retain his position as Vice President in charge of the Construction Machinery Division.

B. F. Devine, who joined the Chain Belt organization in 1909, has been promoted from Sales Manager of the Construction Machinery Division to the position of Manager of the Construction Machinery Division.

The company also announces the appointment of A. W. Thomas as Sales Manager of the Construction Machinery Division, D. A. Kalton as Assistant Sales Manager and A. J. Frank as Assistant to the Manager of the Division.

Galvin, Motorola President, Heads Radio Mfrs. Assn.

The Board of Directors of the Radio Manufacturers Association has elected Paul V. Calvin President of their Association, to succeed the position vacated by James S. Knowlson who recently resigned to become Deputy Director of OPM Priorities Division. Mr. Calvin, President of Motorola Radio, was formerly a Vice President of the RMA, and is present chairman of the Association's

Paul V. Galvin

important Set Division, and also chairman of the Association's Priorities Committee. He has been a leader in industry affairs for several years and will bring an important fund of knowledge to his new position. Mr. Galvin will continue to direct the affairs of his company, the Galvin Manufacturing Corporation of Chicago, makers of Motorola Home and Auto Radio and Police Communication Equipment.

Johns-Manville Names O'Brien Vice-President

The election of John A. O'Brien to the post of vice president of Johns-Manville Sales Corporation was announced

John A. O'Brien

on October 1st by Lewis H. Brown, president of Johns-Manville.

Mr. O'Brien will continue his duties as general sales manager of the power products and industrial department, a post he has held since 1938. He is a member of the J-M Quarter Century Club, having begun his career with the Company in 1915, and is a member of the Engineers Club, New York.

Bailey Meter Company Appoints New Branch Manager

R. M. Cundiff has been appointed manager of its Cincinnati Branch Office at 2512 Carew Tower Building. He succeeds Mr. E. R. Dearborn, former manager whose resignation became effective August 1.

New Appointments

The following new appointments were reported this month:

City Engineers:

W. Frank Rantsma, Fresno, Calif.
J. C. Harper, Lawrence, Kan.
Frank Donnelly, Parsons, Kan.
Jay V. Andrews, Pittsburgh, Kan.
C. W. Stump, Jr., Hagerstown, Md.
Glen Manz, Lansing, Mich.
A. E. Fretheim, Albert Lea, Minn.
William Monahan, Jackson, Ohio.
Parker Sniffen, Logan, Ohio.
H. Lee Wilson, Johnstown, Pa.
Henry J. Johnson, El Campo, Tex.
J. B. Fender, Kaufman, Tex.
Whitworth Cotten, Petersburg, Va.
Charles E. Neville, Chehalis, Wash.
Charles E. Davis, Spokane, Wash.

City Managers:

H. M. Pafford, Douglas, Ga.
William L. Johnson, Ironwood, Mich.
A. B. Sandsbury, Goldsboro, N. C.
James W. Armstrong, Charlotte, N. C.
W. H. Fowler, Ashtabula, Ohio.
R. W. Shoemaker, Westerville, Ohio.

County Engineers:

Halbert Fillinger, Vermillion Co. Newport, Ind.
Hal L. Everett, Elk Co., Howard, Kan.
M. C. Connolly, Dickinson, Iron Mountain, Mich.

Readers' Service Department

These booklets are FREE. Use the coupon below or write the manufacturer direct, mentioning PUBLIC WORKS.

Construction Materials and Equipment

Asphaltic Limestone

5. Characteristics, methods of laying, and results with cold lay mixture shipped ready to use. Especially adapted to resurfacing old pavements, sealcoats and airport runways. Alabama Asphaltic Limestone Co., Liberty Nat. Life Bldg., Birmingham, Ala.

Bituminous Mixer

7. Exact control by volumetric proportioning. Continuous mixing and large capacity. The Barber-Greene mixer can be used as a unit of a travel plant or as a central plant. Excellent and instructive. Well illustrated book on request. Barber-Greene Co., Aurora, Ill.

Cement Dispersion

8. "Economics of Cement Dispersion and Pozzolith" tells the complete story of how cement dispersion reduces water required up to 20% and increases workability 150%. Write The Master Builders Co., Cleveland, Ohio, for a copy.

Cold Mix Plants

10. New catalog and prices of Portable Bituminous Mixers in 6 to 14 ft. sizes for resurfacing and maintenance. Issued by The Jaeger Machine Co., 400 Dublin Ave., Columbus, Ohio.

Concrete Accelerators

29. "How Cotton Quilts are being used successfully for curing concrete" is a series of reprints from recent magazines available on request from Highway Materials Dept., National Automative Fibres, Inc., Little Falls, N. Y.

30. "How to Cure Concrete," a forty-seven page manual published by the Dow Chemical Company, Midland, Michigan, treats fully subject suggested by title.

31. New 48-page booklet in five sections explains clearly the effects, advantages and methods of using Calcium Chloride and Portland Cement mixes. Complete and packed with practical information; well illustrated; pocket size. Sent free on request by Solvay Sales Corp., 40 Rector St., New York, N. Y.

33. Pocket manual of concrete curing with calcium chloride. Complete, handy. Contains useful tables, well illustrated. Write the Columbia Chemical Division, Pittsburgh Plate Glass Co., 30 Rockefeller Plaza, N. Y. C.

Concrete Mixers

44. Catalog and prices of Concrete Mixers, both Tilting and Non-Tilt types, from 3½S to 56S sizes. The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

Concreting in Winter

47. "Build Straight Through the Cold Weather Season" explains briefly how to obtain satisfactory winter concrete in less time. Write Michigan Alkali Co., 60 East 42nd St., New York, N. Y.

Drainage Products

70. Standard corrugated pipe, perforated pipe and MULTI PLATE pipe and arches — for culverts, sewers, subdrains, cattlepasses and other uses are described in a 48-page catalog entitled "ARMCO Drainage Products," issued by the Armco Drainage Products Association, Middletown, Ohio, and its associated member companies. Ask for Catalog No. 12.

71. Modern Culvert Practice — a 72 page book containing valuable data and tables will be sent promptly to anyone interested in drainage by Gohl Culvert Mfrs., Inc., Newport, Ky.

72. "3 Answers to Limited Headroom," a comparison of three ways of providing safe strength and adequate drainage under limited headroom. For copy ask Armco Drainage Products Assn., Middletown, Ohio.

73. "Principles of Design of Airport Drainage" and other articles on airport drainage reprinted from PUBLIC WORKS Magazine are being distributed free by Bowerston Shale Co., Bowerston, O., Hancock Brick & Tile Co., Findlay, O., and Columbus Clay Mfg. Co., Blacklick, O. Address anyone of the above for a copy.

Mud-Jack Method

107. How the Mud Jack Method for raising concrete curb, gutter, walls and street solves problems of that kind quickly and economically without the usual cost of time-consuming reconstruction activities — a new bulletin by Koehring Company, 3026 West Concordia Ave., Milwaukee, Wis.

Paving Materials, Bituminous

111. An excellent booklet issued by The Barrett Co., 40 Rector St., New York, N. Y., describes and illustrates the uses of each grade of Tarvia and Tarvialithic; 32 good illustrations.

114. COLPROVIA PAVING PROCESSES for non-skid pavements include Plant Mixes by both the Heated and Cold Processes, Road Mix Process and Surface Treatment Process. New literature covering these processes is available from Colprovia Roads, Inc., 183 East Main St., Rochester, N. Y.

Paving Materials, Brick

116. "New Developments in Brick Pavements." A review of the developments in brick pavements in recent years. Issued by the National Paving Brick Association, National Press Building, Washingon, D. C.

Pumps

121. New illustrated catalog and prices of Jaeger Sure Prime Pumps, 2" to 10" sizes, 7000 to 220,000 G.P.H. capacities, also Jetting, Caisson, Road Pumps, recently issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

122. CMC pump bulletin illustrates and describes complete line of modern centrifugals made in sizes from 1½" to 10" by Construction Machinery Co., Waterloo, Iowa.

123. New brochure by Gorman-Rupp Co., Mansfield, Ohio, illustrates and describes many of the pumps in their complete line. Covers heavy duty and standard duty self-priming centrifugals, jetting pumps, well point pumps, triplex road pumps and the lightweight pumps.

124. 16-page illustrated bulletin, SP-37, describes and illustrates complete C. H. & E. line of self-priming centrifugal pumps from ½" to 8", including lightweight models for easy portability. C. H. & E. Mfg. Co., 3841 No. Palmer St., Milwaukee, Wis.

Retaining Walls

126. Charts showing the design of cellular or bin-type metal retaining walls, helpful suggestions on their use for stabilizing slopes, preventing stream encroachment, and solving problems of limited right of way, and construction details are given in a 16-page bulletin entitled, "ARMCO Bin-Type Retaining Walls." It is published by the Armco Drainage Products Association, Middletown, Ohio, and member companies. Ask for Bulletin H-37.

127. See road work as it was done in the 1890's and as it can be done by a full line of this year's road building equipment. See, in this new action picture book, the first reversible roller, 1893 World's Fair Award Grader and how methods have changed. Attractive new booklet AD-1796 recently issued by The Austin-Western Road Machinery Co., Aurora, Ill.

128. Motor Patrol Graders for road maintenance, road widening and road building, a complete line offering choice of weight, power, final drive and special equipment to exactly fit the job. Action pictures and full details are in catalogs Nos. 253, 254 & 255, issued by Galion Iron Works & Mfg. Co., Galion, Ohio.

129. New bulletins illustrate and describe the latest line of Littleford Utility Spray Tanks, Street Marking Units, Street Flushers and Kettles. Littleford Bros., 452 East Pearl St., Cincinnati, Ohio.

130. Toro patching rollers, tractors and mowers for parks, airports, estates, highways and golf courses are pictured and detailed in new illustrated booklet available from Toro Mfg. Co., Minneapolis, Minn.

Rollers

133. New Tu-Ton roller of simple construction for use in rolling sidewalks along highways, playgrounds and other types of light rolling is fully described in a bulletin issued by C. H. & E. Mfg. Co., 3841 No. Palmer St., Milwaukee, Wis.

138. "The Buffalo-Springfield line of road rollers (tandem, 3-wheel, and 3-axle) are described in the latest catalog issued by the Buffalo-Springfield Roller Co., Springfield, Ohio."

139. "Ironeroller" 3 Axle Roller for extra smooth surfaces on all bituminous work. Booklet contains roller data and operation details. Hercules Co., Marion, Ohio.

Skating Pond Sprays

141. How to make safe skating rinks on any vacant lots with the handy Masbruch spray is described in new literature issued by Russell Manufacturing Co., Dept. 2, Platteville, Wis.

Spreader

147. Jaeger Paving equipment, including Mix-in-Place Roadbuilders, Bituminous Pavers, Concrete Bituminous Finishers, Adjustable Spreaders, Forms, etc.— 4 complete catalogs of latest equipment in one cover, issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

Soil Stabilization

150. "High-Service, Low Cost Roads" is one of the newer booklets using an effective combination of picture and text to set forth the principals and advantages of road surface stabilization with calcium chloride. Complete, interesting and well illustrated. 34 pages. Sent by Solvay Sales Corp., 40 Rector St., New York, N. Y.

152. The Columbia Alkali Corpora-

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Readers' Service Department

(Continued from page 55)

tion, will be glad to furnish to anyone interested complete information dealing with Calcium Chloride Stabilized Roads. This literature contains many charts, tables and useful information and can be obtained by writing Columbia Alkali Div., Pittsburgh Plate Glass Co., 30 Rockefeller Plaza, New York City.

154. "Soil Stabilization with Tarvia"—An illustrated booklet describing The steps in the stabilization of roadway soil with Tarvia will be mailed on request by The Barrett Company, 40 Rector St., New York, N. Y.

Tractors

159. "International Diesel TracTracTors" is a 48-page catalog giving full details of TracTracTors, including action pictures with bulldozers, bullgraders, blade graders, wheel scrapers, elevating graders, etc. Sent promptly by International Harvester Co., 180 North Michigan Ave., Chicago, Ill.

Street and Paving Maintenance

Asphalt Heaters

198. Illustrated Bulletins 15 to 20 describe Mohawk Oil Burning Torches; "Hotstuf" Tar and Asphalt Heaters; Portable Trailer Tool Boxes; Pouring Pots and other equipment for street and highway maintenance, roofing, pipe coating, water proofing, etc. Mohawk Asphalt Heater Co., Frankfort, N. Y.

Dust Control

210. "How to Maintain Roads with Dowflake" is a new 58 page illustrated booklet of information on stabilized road construction. Includes specifications and several pages of reference tables from an engineer's notebook. Issued by Dow Chemical Co., Midland, Mich.

211. A complete booklet on dust control titled, "Dust Control and Road Stabilization," describes the use of Columbia Calcium Chloride for dust control purposes and stabilization of roads. Sent on request by Columbia Alkali Div., Pittsburgh Plate Glass Co., 30 Rockefeller Plaza, New York, N. Y.

212. "Are You Annoyed by Dust?" an illustrated circular telling how to prevent dust with calcium chloride. Sent free by Michigan Alkali Co., 60 East 42 St., New York, N. Y.

Radio Communication, Two Way

250. Valuable information on how cities and towns all over the country have solved their radio communication problems is found in "Motorola Radio Communication Equipment." Write Galvin Mfg. Corp., 4545 West Augusta St., Chiccago, Ill.

Street Markers

300. Street marking simplified by the use of modern, self-contained units capable of handling any kind of striping jobs is the subject of an illustrated bulletin giving also full details of new M-B Street Markers. Sent by Meili-Blumberg Corp., Box PW, New Holstein, Wis.

Snow Fighting

Plows

350. "Frink One-Way Sno-Plows" is a four page catalog illustrating and describing 5 models of One-Way Blade Type Sno-Plows for motor trucks from 1½ up to 8 tons capacity. Interchangeable with V Sno-Plow. Features, specifications and method of attaching. Carl H. Frink, Mfr., Clayton, 1000 Islands, N. Y.

Ice Control

351. "Make Icy Highways Safe for Traffic"—a new bulletin by Michigan Alkali Co., 60 East 42 St., New York, N. Y., tells how to use calcium chloride for modern ice control.

Sanitary Engineering

Activated Alum

354. "Technical Data on Activated Alum and Dustless Blackalum" points out the analytical side of Activated Alum and Blackalum. Write Activated Alum Corp., Curtis Bay, Baltimore, Md.

Aero-Filter

356. New illustrated bulletin gives complete information on design of Aero-Filters to provide high-capacity, uniform, raindrop application over the entire filter bed. Write Lakeside Engineering Corp., 222 West Adams St., Chicago, Ill.

Air Release Valves

357. Automatic Air Release Valves for water, sewage and industrial uses are described and illustrated in new catalog issued by Simplex Valve & Meter Co., 6750 Upland St., Philadelphia, Pa.

Analysis of Water

360. "Methods of Analyzing Water for Municipal and Industrial Use" is an excellent 94 page booklet with many useful tables and formulas. Sent on request by Solvay Sales Corp., 40 Rector St., New York, N. Y.

Activation and Aeration

376. A valuable booklet on porous diffuser plates and tubes for sewage treatment plants. Covers permeability, porosity, pore size and pressure loss data, with curves. Also information on installations, with sketches and pictures, specifications, methods of cleaning and studies in permeability. 20pp. illustrated. Sent on request to Norton Company, Worcester, Mass.

Cleaning Sewers

383. A 20-page booklet describes and illustrates a full line of sewer cleaning equipment—Rods, Root Cutters, Buckets, Nozzles and Flushers. Write W. H. Stewart (Pioneer Mfr. since 1901), Jacksonville, Fla., or P. O. Box 767, Syracuse, N. Y.

384. A new 32-page, illustrated booklet explains how a city can clean its sewers and culverts with its own forces using the up-to-date Flexible Sewer Rod equipment. Illustrates and describes all necessary equipment. Issued by Flexible Sewer Rod Equipment Co., 9059 Venice Boul., Los Angeles, Calif.

Feeders, Chlorine, Amonia and Chemical

387. For chlorinating water supplies, sewage plants, swimming pools and feeding practically any chemical used in sanitation treatment of water and sewage. Flow of water controls dosage of chemical; reagent feed is immediately adjustable. Starts and stops automatically. Literature from % Proportioneers, Inc. % 96 Codding St., Providence, R. I.

Filter Bed Agitator

388. 60-page booklet, "The Mechanics of Filter Bed Agitation," containing engineering data, technical information concerning surface wash and opinions of users will be sent promptly by Activated Alum Corp., Curtis Bay, Baltimore, Md.

Filter Plant Controllers

389. "The Modern Filter Plant" and the uses of Simplex Controllers for operation are described in a handy, 16-page booklet. Charts, data, curves and tables. Simplex Valve and Meter Co., 6750 Upland St., Philadelphia, Pa.

Fire Hydrants

390. Specifications for standard AWWA fire hydrants with helpful instructions for ordering, installing, repairing, lengthening and using. Issued by M. & H. Valve & Fittings Co., Anniston, Ala.

391. See listing No. 410.

Flow Meters

393. The primary devices for flow measurement—the orifice, the pilot tube, the venturi meter and others — and the application to them of the Simplex meter are described in a useful 24-page booklet (42A). Simplex Valve and Meter Co., 6750 Upland St., Philadelphia, Pa.

Gates, Valves, Hydrants

394. Gate, flap and check valves; floor stands and fittings. New catalog No. 34 gives detail information with dimensions for all types of new full line. M. & H. Valve & Fittings Co., Anniston, Ala.

395. Complete booklet with much worthwhile water works data describes fully Ludlow hydrants and valves. Sent on request. Ludlow Valve Mfg. Co., Troy, N. Y.

396. See listing No. 410.

Gauges

398. The full line of Simplex gauges for filtration plants are illustrated and described in catalog issued by Simplex Valve and Meter Co., 6750 Upland St., Philadelphia, Pa.

Hypochlorinators

400. New illustrated booklet W&T 357 describes this simple, inexpensive means of protecting small water supplies such as summer camps, hotels, swimming pools, dairies, etc., as well as for feeding chemical solutions in the water works plant. Contains typical installation sketches. Write "Wallace & Tiernan Co., Inc., Newark, N. J.

Manhole Covers and Inlets

402. Street, sewer and water castings in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter crossing plates, valve and lamphole covers, ventilators, etc. Described in catalog issued by South Bend Foundry Co., Lafayette Boul. and Indiana Ave., South Bend, Ind.

Manhole Cover Silencers

403. New bulletin on Tapax for quickly ending noisy manhole covers and small sample free. Write Tapax Mfg. Co., 201 Hoyt Ave., Mamaroneck, N. Y.

Meters, Venturi

405. MS Meters for use with venturi tubes, flow nozzles, etc., in wall, panel, or floor mounting are covered in detail in catalog sent free by Simplex Valve & Meter Co., 6750 Upland St., Philadelphia, Pa.

406. New bulletin illustrates Builders Air Relay system of transmission for the Venturi Meter which is particularly useful for liquids containing suspended solids like sewage. Eliminates corroson, clogged pipes, etc. Write Builders Iron Foundry, Codding St., Providence, R. I.

Meters, Water

407. Complimentary bulletin W529 tells all about Pittsburgh IMO water meters, "the meters that wear in where others wear out." Write Pittsburgh Equitable Meter Co., Pittsburgh, Pa.

Pipe, Cast Iron

408. Handbook of Universal Cast Iron Pipe and Fittings, pocket size, 104 pages, illustrated, including 14 pages of useful reference tables and data. Sent by The Central Foundry Co., 386 Fourth Ave., New York, N. Y.

409. Cast iron pipe and fittings for water, gas, sewer and industrial service. Super-deLavaud centrifugally-cast and pit-cast pipe. Bell-and-spigot, U. S. Joint, flanged or flexible joints can be furnished to suit requirements. Write U. S. Pipe and Foundry Co., Burlington, N. J.

410. "Cast Iron Pipe and Fittings" is a well illustrated 44 page catalog giving full specifications for their complete line of Sand Spun Centrifugal Pipe, Fire Hydrants, Gate Valves, Special Castings, etc. Will be sent promptly by R. D. Wood Co., 400 Chestnut St., Philadelphia, Pa.

Pipe Forms

411. Making concrete pipe on the job to give employment at home is the subject of a new booklet just issued by Quinn Wire and Iron Works, 1621 Twelfth St., Boone, Ia., manufacturers of "Heavy Duty" Pipe Forms. Sent promptly on request.

Pipe, Reinforced Concrete

412. Literature describing the manufacture and installaton of Lock Joint Reinforced Concrete Pressure Pipe for water supply lines and sewer force mains. Lock Joint Pipe Co., Ampere, N. J.

Pipe, Transite

413. Two new illustrated booklets, "Tansite Pressure Pipe" and "Transite Sewer Pipe" deal with methods of cutting costs of installation and maintenance of pipe lines and summarize advantages resulting from use of Transite pipes. Sent promptly by Johns-Manville Corp., 22 East 40th St., New York, N. Y.

Pipe Joints, Sewer

415. How to make a perfect sewer pipe joint—tight, prevents roots entering sewer, keeps lengths perfectly aligned; can be laid with water in trench or pipe. General instructions issued by L. A. Weston, Adams, Mass.

Pipe, 2-inch Cast Iron

417. The new McWane 2" cast iron

pipe in 18-foot lengths has innumerable uses in water and sewage work. Send for the new McWane bulletin describing this pipe, the various joints used, and other details about it. McWane Cast Iron Pipe Co., Birmingham, Ala.

Pumps and Well Water Systems

420. Installation views and sectional scenes on Layne Vertical Centrifugal and Vertical Turbine Pumps fully illustrated and including useful engineering data section. Layne Shutter Screens for Gravel Wall Wells. Write for descriptive booklets. Advertising Dept., Layne & Bowler, Inc., Box 186, Hollywood Station, Memphis, Tenn.

Meter Setting and Testing

430. The most complete catalog we have seen on setting and testing equipment for water meters—exquisitely printed and illustrated 48-page booklet you should have a copy of. Ask Ford Meter Box Co., Wabash, Ind.

Recarbonation

431. Bulletin describes stabilizing lime-softened water by recarbonation, discussing gas production, washing, compressing, drying, and applying the CO(2). International Filter Co., 325 West 25th Place, Chicago, Ill.

Sand Expansion Indicator

432. New bulletin gives full details of Simplex Sand Expansion Indicators for water plants. Write Simplex Valve & Meter Co., 6750 Upland St., Philadelphia, Pa.

434. Be assured of uninterrupted, constant automatic removal of screenings. Folder 1587 tells how. Gives some of the outstanding advantages of "Straightline Bar Screens" (Vertical and Inclined types). Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill.

Steel Sheet Piling

435. Steel sheet piling to speed sewer jobs is covered in illustrated catalog containing complete production specifications. Write Dept. PW-2, The Union Metal Mfg Co., Canton, Ohio.

436. "Metal Sheeting for Lower Average Job Costs" is a new bulletin about light weight sheeting you can use again and again. Issued by Armco Drainage Products Assn., Middletown, Ohio.

Sewers

437. "ARMCO Sewers" is the title of a 48-page booklet describing the structural and other advantages of ARMCO Ingot Iron. Paved Invert and Asbestos-Bonded pipe for storm and sanitary sewers. Design data and large charts will be found helpful by engineers engaged in the design or construction of sewers. Copies will be sent on request by the Armco Drainage Products Association, Middletown, Ohio, or its associated member companies.

Septic Tanks, Small

438. Septic Disposal Systems, Waterless Toilets, Multiple Toilets for Camps and Resorts, and other products for providing safer sewage disposal for unsewered areas are described and illustrated in data sheets issued by San-Equip Inc., 504 E. Glen St., Syracuse, N. Y.

Sludge Drying and Incineration

440. "Disposal of Municipal Refuse." Complete specifications and description including suggested form of proposal; form of guarantees; statements and approval sheet for comparing bids with diagramatic outline of various plant designs. 48 pages. Address: Morse Boulger Destructor Co., 216-P East 45th St., New York, N. Y.

441. Full information about Nichols modern, efficient gabage and refuse incinerators now available in the Basket Grate, Continuous Grate, Revolving Grate and Monohearth types will be sent promptly by Nichols Engineering and Research Corp., 60 Wall Tower, New York, N. Y.

442. Recuperator tubes made from Silicon Carbide and "Fireclay" Corebusters for maximum efficiency are described and illustrated in bulletin No. 11 issued by Fitch Recuperator Co., Plainfield National Bank Bldg., Plainfield, N. J.

443. Nichols Herreshoff incinerator for complete disposal of sewage solids and industrial wastes — a new booklet illustrates and explains how this Nichols incinerator works. Pictures recent installations. Write Nichols Engineering and Research Corp., 60 Wall Tower, New York, N. Y.

Swimming Pools

446. Data and complete information on swimming pool filters and recirculation plants; also on water filters and filtration equipment. For data prices, plans, etc., write Roberts Filter Mfg. Co., 640 Columbia Ave., Darby, Pa.

447. 40-page Manual on swimming pools. Includes swimming and pool layouts, specifications, etc., and details concerning Permutit Swimming Pool Equipment. Write The Permutit Co., Dept. G-4, 330 West 42 St., New York, N. Y.

Taste and Odor Control

450. Technical pub. No. 207 issued by Wallace & Tiernan Co., Inc., Newark, N. J., describes in detail taste and odor control of water with BREAK-POINT Chlorination, a method of discovering the point at which many causes of taste may be removed by chlorination with little or no increase in residual chlorine. Sent free to any operator requesting it.

452. "Water and Sewage Chemistry" is the title of a valuable booklet for the operating man, reprinted from PUBLIC WORKS Magazine for December, 1940, by General Chemical Co., 40 Rector St., New York, N. Y.

Treatment

453. "Safe Sanitation for a Nation," an interesting booklet containing thumbnail descriptions of the different pieces of P.F.T. equipment for sewage treatment. Includes photos of various installations and complete list of literature available from this company. Write Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill.

455. New booklet (No. 1642 on Link-Belt Circuline Collectors for Settling Tanks contains excellent pictures; drawings of installations, sanitary engineering data and design details. Link-Belt Company, 2045 W. Hunting Park Ave., Philadelphia.

456. New 16-page illustrated catalog No. 1742 on Straightline Collectors for the efficient, continuous removal of sludge from rectangular tanks at sewarage and water plants. Contains layout drawings, installation pictures, and capacity tables. Address Link-Belt Co., 2045 West Hunting Park Ave., Philadelphia, Pa.

457. New illustrated folder (1942) on Straightline apparatus for the removal and washing of grit and detritus from rectangular grit chambers. Address: Link-Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.

458. "Sedimentation with Dorr Clarifiers" is a complete 36-page illustrated catalog with useful design data. Ask The Dorr Company, 570 Lexington Ave., New York, N. Y.

459. A combination mechanical clarifier and mechanical digester, The Dorr Clarigester, is explained and illustrated in a bulletin issued by The Dorr Company, 570 Lexington Ave., New York, N. Y.

460. This new 145 page illustrated chemical products book contains 55 pages of Tables, Factors and valuable Reference Data. Issued by General Chemical Co., 40 Rector St., New York, N. Y.

461. Preflocculation without chemicals with the Dorrco Clariflocculator in a single structure is the subject of a new booklet issued by The Dorr Company, 570 Lexington Ave., New York, N. Y.

462. Dorrco Monorake for existing rectangular sedimentation tanks, open or closed, is described and illustrated in a new catalog sent on request. The Dorr Co., 570 Lexington Ave., New York, N. Y.

Tunnel Liners

480. "Save Money with Armco *Light Duty* Tunnel Liner" is a bulletin you'll want if you are interested in economical, long lasting tunnels. Write Armco Drainage Products Assn., Middletown, Ohio.

Valves (See Gates, Air Release, etc.)

Water Works Operating Practices

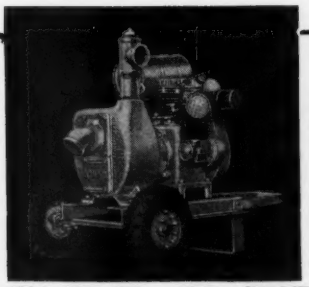
490. "Important Factors in Coagulation" is an excellent review with bibliography and outlines of latest work done in the field. Written by Burton W. Graham and sent free on request to Activated Alum Corp., Curtis Bay, Baltimore, Md.

491. "Soft Water for Your Community" tells by means of many interesting pictures and text the advantages of soft water to any community. Ask for a copy from The Permutit Co., Dept. G4, 330 West 42nd St., New York, N. Y.

492. "Alkalies and Chlorine in the Treatment of Municipal and Industrial Water" is a new comprehensive survey filled with tables, charts, cost comparisons, etc., valuable to all who treat large volumes of water. Write Solvay Sales Corp., 40 Rector Street, New York City.

Water Service Devices

500. Data on anti-freeze outdoor drinking fountains, hydrants, street washers, etc., will be sent promptly on request to Murdock Mfg. & Supply Co., 426 Plum St., Cincinnati, Ohio.



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STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933.

OF PUBLIC WORKS, published monthly at New York, N. Y., for October 1, 1941.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Croxton Morris, who, having been duly sworn according to law, deposes and says that he is the Business Manager of the PUBLIC WORKS and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Public Works Journal Corp., 310 East 45th St., New York, N. Y.; editor, A. Prescott Folwell, 310 East 45th St., New York, N. Y.; managing editor, none; business manager, Croxton Morris, 310 East 45th St., New York, N. Y.

2. That the owner is (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.

Public Works Journal Corp., J. T. Morris, Croxton Morris, A. Prescott Folwell and Anna Morris, all of 310 East 45th St., New York, N. Y.; W. A. Hardenbergh, Washington, D. C.; Wesley Hardenbergh, Golf, Ill., and S. N. Hume, address unknown.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) Bertha Morris, White Plains, N. Y.; Mary Sunderland, Liberty, N. Y.; Estate of Elizabeth Hardenbergh, White Sulphur Springs, N. Y.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the twelve months preceding the date shown above is ..... (This information is required from daily publications only.)

CROXTON MORRIS, Business Manager.

Sworn to and subscribed before me this 11th day of October, 1941.

CULLEN B. HARDY
Notary Public, Westchester County, N. Y.
Cert. filed in N. Y. Co. No. 922
My commission expires March 30, 1942.
(Seal)

A New Catalog for You!

Wouldn't you like to have the latest edition of our Parts Catalog in your files for ready reference? All parts of Murdock Water Devices are so carefully machined as to be interchangeable.

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426 Plum St. Cincinnati, O.

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SELF-CLOSING ANTI-FREEZING HYDRANT
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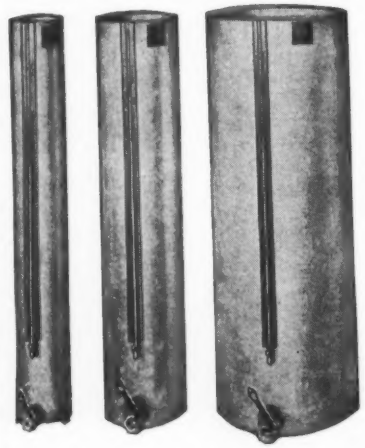
Accurate, durable and dependable. Made in five sizes; calibrated in gallons and cu. ft., also in percentages fast and slow.



These tanks are made of heavily galvanized steel, have quick opening drain valves and brass gauge strips.

FORD METER BOX CO.
WABASH, IND.

For the Engineer's Library

Brief reviews of the latest books, booklets and catalogs for the public works engineer.

Cold Weather Concreting and Better Concrete Curing

Calcium Chloride Assn.
4145 Penobscot Bldg., Detroit, Mich.

A revised 12-page bulletin on "Cold Weather Concreting, High Early Strength and Better Concrete Curing" has recently been issued by the Calcium Chloride Association, 4145 Penobscot Building, Detroit, Michigan. Containing detailed information on the effects and advantages of adding calcium chloride to concrete mixtures, the bulletin is also well illustrated with photographs and charts. Included are the latest A.S.T.M. specifications for using calcium chloride in dry flake form, as well as in solution, covering the incorporation of the chemical as an admixture and its use as a surface curing agent.

Copies of this interesting bulletin are available without charge to all interested persons upon request addressed to the Calcium Chloride Association.

Sludge Drying and Incineration

The Dorr Co., New York, N. Y.

A new and revised bulletin on the C-E Raymond System of Sludge Drying and Incineration—a product of Combustion Engineering Company, Inc., which is marketed exclusively, in the sanitary engineering field, by the Dorr Company, Inc., has just been published.

This bulletin is far more complete than the earlier edition of two years ago. Attention is especially directed to the series of wash drawings appearing in this bulletin, to indicate the functional workings of the system.

The three and four color flow diagrams on pages 11 and 16, respectively, are said to make the workings of this system more understandable than ever before. On page 8 there is a very detailed tabulation giving design data on 12 installations. Write The Dorr Co. for a copy.

Trinity White Cement Handbook

Trinity Portland Cement Co.
Dallas, Tex.

A common-sense study of white cement and pertinent facts about its many uses are clearly explained in a convenient little handbook just published by the Trinity Portland Cement Company, Dallas, Texas.

Tests to evaluate the whiteness of different cements are explained, so that anyone who wants to make his own investigation may do so easily. The Company also offers free samples of its cement to those who want to make the suggested tests. Trinity White is now being sold nationally.

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